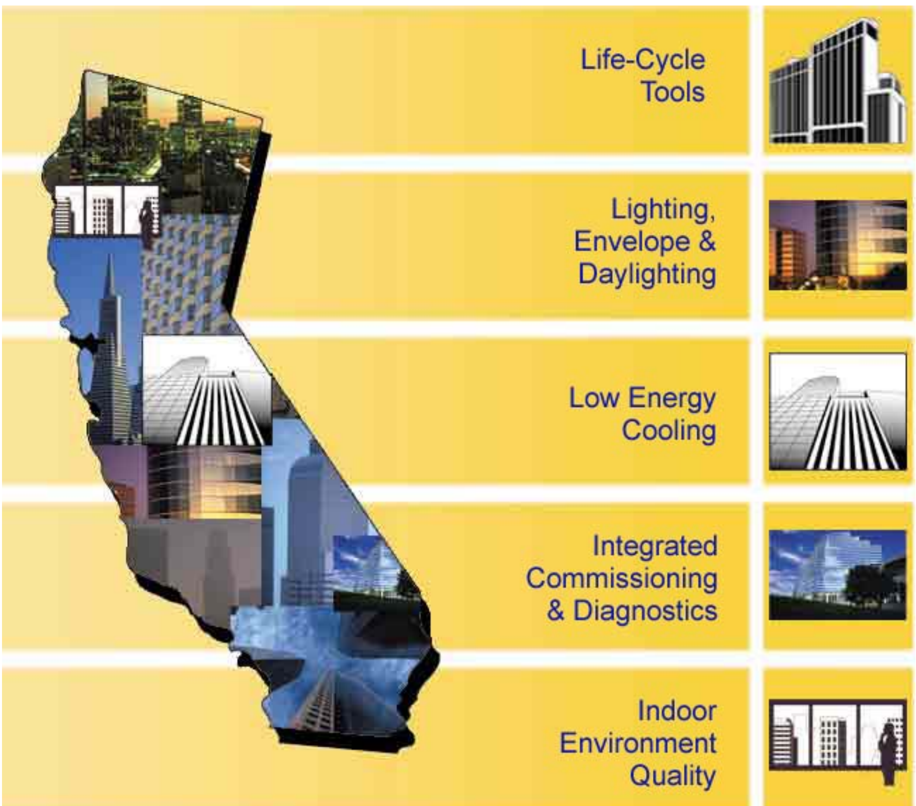
CALIFORNIA
ENERGY
COMMISSION

Turning EMCS into Monitoring Systems



TECHNICAL REPORT

October 2003
500-03-097-A15

STATE OF CALIFORNIA
ENERGY COMMISSION

Gray Davis, *Governor*

CALIFORNIA ENERGY COMMISSION

Prepared By:
Buildings Technologies Department
Lawrence Berkeley National Laboratory

Steve Selkowitz
B90R3110
1 Cyclotron Road
E. O. Lawrence Berkeley National Laboratory
Berkeley, CA 94720

CEC Contract No. 400-99-012

Prepared For:
Martha Brook,
Contract Manager

Nancy Jenkins,
PIER Buildings Program Manager

Terry Surles,
PIER Program Director

Robert L. Therkelsen
Executive Director

Acknowledgements

In a program of this magnitude there are many people who contributed to its success. We owe the many staff members, faculty, and students of the different institutions our thanks for the superb work and long hours they contributed. All of their names may not appear in this report, but their efforts are visible in the many papers, reports, presentations, and thesis that were the major output of this program.

The EETD leadership provided support in many ways. We thank Mark Levine, Marcy Beck, and Nancy Padgett. Members of the Communications Department of EETD helped in preparing reports, presentations, handouts, and brochures. The help of Allan Chen, Julia Turner, Anthony Ma, Steve Goodman, Sondra Jarvis, and Ted Gartner is acknowledged.

Special thanks are given to the support staff from the Buildings Technologies Program at LBNL: JeShana Dawson, Rhoda Williams, Denise Iles, Catherine Ross, Pat Ross, and Danny Fuller. Norman Bourassa performed a wide range of duties, from original research to tracking deliverables.

We thank the following members of the Program Advisory Committee (PAC) for their advice and support. In a program designed to deal with real world problems their ideas were vital. The PAC members are:

Larsson, Nils .... C2000 Canada
Stein, Jay .... E-Source
Wagus, Carl .... Am. Architectural Manufs. Assoc.
Lewis, Malcolm .... Constructive Technologies
Bernheim, Anthony .... SMWM Architects
MacLeamy, Patrick .... HOK
Mix, Jerry .... Wattstopper
Waldman, Jed .... CA Dept of Health Services
Bocchicchio, Mike .... UC Office of the President
Prindle, Bill .... Alliance to Save Energy
Sachs, Harvey .... ACEEE
Browning, Bill .... Rocky Mountain Institute
Lupinacci, Jean .... U.S. EPA
Goldstein, Dave .... Natural Resources Defense Council
Smothers, Fred .... Smother & Associates
Benney, Jim .... NFRC Director of Education
Stewart, RK .... Gensler Assoc
Angyal, Chuck .... San Diego Gas & Electric
Ervin, Christine .... US Green Buildings Council
Ginsberg, Mark .... US Department of Energy
Higgins, Cathy .... New Buildings Institute

Finally, we acknowledge the support and contributions of the PIER Contract Manager, Martha Brook, and the Buildings Program team under the leadership of Nancy Jenkins.

Preface

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The Program's final report and its attachments are intended to provide a complete record of the objectives, methods, findings and accomplishments of the High Performance Commercial Building Systems (HPCBS) Program. This Commercial Building Energy Benchmarking attachment provides supplemental information to the final report (Commission publication # 500-03-097-A2). The reports, and particularly the attachments, are highly applicable to architects, designers, contractors, building owners and operators, manufacturers, researchers, and the energy efficiency community.

This document is the fifteenth of 22 technical attachments to the final report, and consists of research reports:

- Data Logging Guide for Andover Controls Energy Management and Controls Systems (E5P2.2T2a1)
- Data Logging Guide for Siemens – EMCS (E5P2.2T2a2)
- Data Logging Guide for TAC-Americas – EMCS (E5P2.2T2a3)

The Buildings Program Area within the Public Interest Energy Research (PIER) Program produced this document as part of a multi-project programmatic contract (#400-99-012). The Buildings Program includes new and existing buildings in both the residential and the nonresidential sectors. The program seeks to decrease building energy use through research that will develop or improve energy-efficient technologies, strategies, tools, and building performance evaluation methods.

For the final report, other attachments or reports produced within this contract, or to obtain more information on the PIER Program, please visit http://www.energy.ca.gov/pier/buildings or contact the Commission's Publications Unit at 916-654-5200. The reports and attachments are also available at the HPCBS website: http://buildings.lbl.gov/hpcbs/.

Abstract

Data Logging Guides have been completed for EMCSs by Andover Controls, Siemens EMCS, and TAC Americas.

Each guide describes detailed procedures to determine the monitoring capability of the existing EMCS and to upgrade the EMCS to enable data logging. The guide outlines procedures that will enable the existing EMCS to measure hourly energy consumption of a building or facility. The parameters to monitor include electricity consumption, thermal consumption (flow and temperatures), room temperature, and other physical variables.

Each guide helps users understand and verify configuration of the existing controller to monitor the above parameters.

This process includes:

Determining the functionality of the existing EMCS controller model and software version
Upgrading the physical monitoring capability of the existing controller, if needed
Selecting the correct sensors for the application in existing EMCS controllers
Following procedures to set up and configure the EMCS to log the desired data

Once these procedures are fully implemented, the existing EMCS can be effectively used as a data logger. The guides offer a very cost-effective method of acquiring data-logger-quality monitoring from an existing EMCS.

California Energy Commission
Public Interest Energy Research Program

HPCBS # E5P2.2T2a

HPCBS

High Performance Commercial Building Systems

Data Logging Guide for Andover Controls Energy Management and Control Systems

Element 5 - Integrated Commissioning and Diagnostics
Project 2.2 - Monitoring and Commissioning of Existing Buildings
Task 2.3.1 - Develop a guide to implementation of monitoring systems in existing buildings

Charles Culp
Energy Systems Laboratory, Texas A&M University
January 2003

California Energy Commission

Data Logging Guide

for

Andover Controls

Energy Management and

Control Systems

Submitted by

Energy Systems Laboratory
Texas A&M University

Acknowledgments

This work was completed under contract to Lawrence Berkeley National Laboratory as part of the High Performance Commercial Building Systems program. This program is supported by the California Energy Commission's Public Interest Energy Research (PIER) Buildings Program and the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technology, Building Technologies Program, of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

Numerous individuals contributed to completing the Guide. Andover Controls assigned key engineers to this effort. Yasuko Sakurai from the Energy Systems Laboratory was the lead engineer on this effort. She spent several months researching engineering details to make this a usable guide. Lindsey Turns and Lindsay Patton also spent considerable time in reviewing and editing this work. The project lead was Charles Culp, P.E., Ph.D., Associate Director of the Energy Systems Laboratory and Visiting Professor at Texas A&M University.

The authors also thank Andover Controls for their supporting data and collaboration during this study. John Williamson spent numerous hours compiling the information and also reviewing the Guide for accuracy.

Table of Contents

Executive Summary

This Guide presents detailed procedures to determine the monitoring capability of an existing EMCS (Energy Management Control System) and perform any upgrades to the EMCS to enable data logging. This Guide outlines procedures to enable an existing EMCS to measure the hourly energy consumption of a building or facility. The parameters to monitor include electrical consumption, thermal consumption (flow and temperatures), room temperature and other physical parameters.

This Guide enables the user to understand and verify how the existing controller can be configured to monitor the above parameters. Briefly, this includes:

- Determining the functionality of the existing EMCS controller models and software versions.
- Upgrading the physical monitoring capability of the existing controller, if needed.
- Selecting the correct sensors for the application in existing EMCS controllers.
- Following procedures to set-up and configure the EMCS to log the desired data.

Once these procedures are fully implemented, the existing EMCS can be effectively used as a data logger. This results in a very cost effective method to acquire data logger quality data in an existing EMCS.

CHAPTER 1. INTRODUCTION

This Guide covers products designed by Andover Controls and introduced since 1994. A complete list of Andover Controls software and hardware products that have been installed since 1994 are detailed in this Guide. Improvements to the products are also covered. This Guide presents detailed procedures to determine the monitoring capability of an existing Andover Controls EMCS (Energy Management Control System) and perform any needed upgrades to the EMCS to enable data logging.

Chapter 2 covers how to determine the functionality of the existing EMCS controller and software versions. Also covered is how to determine if upgrades are needed to the existing system. After implementing the steps in Chapter 2, the base system will be ready to be configured and used as a data logger.

Chapter 3 then covers specifically how to set-up and configure the EMCS as a data logger. Procedures are provided to enable selected data logger monitoring functions. These include electrical consumption, thermal flow and room monitoring. Data collection and storage requirements are also provided.

The Appendices covers programming details and accuracy determinations. A specific electrical consumption accumulation program, a thermal consumption calculation program and an extended log archiving program are provided. An example of temperature accuracy is provided so that the user can better determine the accuracy of thermal measurements.

This Guide enables the user to understand and verify that the existing controller can be configured to monitor the above parameters. Briefly, this includes:

- Determining the existing EMCS controller models and software versions.
    - Table 1 in Chapter 2 lists Andover Controls' controllers and software versions. If the existing controller models and software versions found in the facility are listed in

Table 1, this Guide can be used to upgrade the EMCS to store historical data of the parameters needed to determine the hourly energy consumption in a facility.

- Upgrading the physical monitoring capability of the existing controller, if needed.
  - Chapter 2 contains guidance on what will need to be upgraded based on the existing EMCS models and software.
- Selecting the correct sensors for the application in existing EMCS controllers.
  - Chapter 3 provides information about what input types different controllers can accept and provides accuracy of the sensors. Guidance in selecting the correct sensor type is provided.
- Following procedures to set-up and configure the EMCS to log the desired data.
  - Chapter 3 provides procedures to configure the EMCS to log data for specific applications. The applications include electrical consumption and demand monitoring using a Watt-Hour transducer, electrical consumption and demand monitoring using a Watt transducer, thermal monitoring using a BTU meter or EMCS, monitoring room temperature and data collection and storage guidance.

CHAPTER 2. DETERMINE EXISTING SYSTEM FUNCTIONALITY

Step 1: Check the software version and the existing controller model of the controller connected to the sensor that will be used.

Step 2: Verify the firmware release and hardware/software compatibility.

Step 3: Find the general specification of the controller and the input type for each controller.

Step 4: Check data logging performance of controller.

Step 5: Upgrade EMCS for data logging

Details of each step follow.

Step 1: Check the software version and the existing controller model of the controller connected to the sensor that will be used

If the controller model is listed in Table 1, this Guide can provide a guideline to set-up and store the history data. If the existing controller model is not included, consult with Andover Controls for the possibility of using the existing controller or upgrading it to a current model.

Table 1. Andover Controls Hardware and Software Products

Hardware	
Controller Family	Model Number
Continuum System	Continuum NetController CPU Module I/O Modules • UI-8-10 • DI-8 • MI-6
Infinity System Controller	SCX 920 LCX 800, LCX 800 I LCX 810
An Eclipse Controller	Eclipse CX 9400 Central Processing Unit Eclipse I/O Modules • UI-32-12, UI-16-12, UI-32-16 or UI-16-16 • DI-32-DRY
Software	
Continuum™ CyberStation™ Workstation Software SX 8000 Front End Software	

There are three families of controllers for use as monitor and control instruments: the Continuum System, the Infinity System and the Eclipse Controller system. These controllers are categorized into two types of controllers, Network controllers and Infinet controllers. While Network controllers are controllers that reside on and communicate through an Ethernet network (primary network), Infinet controllers are special function stand-alone controllers that communicate with Network controllers through a proprietary network called the Infinet (secondary network).

NetController and Eclipse CX 9400 are examples of Network controllers with the input/output modules. These controllers consist of a CPU module and memory and communication ports including interface to distributed Infinity Infinet Controllers. They provide network management and full system control of a building. Another example of a Network controller is CMX 240. It is a system coordinator for Infinet controllers with direct-connect or dial-up communication ability. CMX 240 does not have input/output module reading. Therefore, it cannot be used directly for monitoring but can be the coordinator for Infinet controllers. The examples of special function Infinet controllers are SCX and LCX series controllers.

- <u>Continuum NetController CPU</u>: This controller acts as the system coordinator for the Continuum I/O modules. It provides integrated global control and monitoring, history logging, and local and remote alarming. The following I/O modules are used with this controller:
    - UI-8-10: Provides 8 universal inputs which are software configurable as either voltage, thermistor, digital or counter point types.
    - DI-8: Provides 8 digital inputs which are software configurable to accept a digital or counter signal.
    - MI-6: Perfect match for temperature transmitters, humidity and pressure transducers, and gas monitors with either a 0-24mA or 4-20mA output.

- <u>SCX 920</u>: This controller is a standalone, programmable microprocessor-based system controller that is used for direct digital control (DDC) of chillers, cooling towers, boilers, air handling units, perimeter radiation, lighting, etc. The controller has 16 universal inputs, 8 universal outputs, and contains an I/O expansion port.

- <u>LCX 800</u>: The LCX 800 is a standalone, programmable microprocessor-based controller used for DDC and monitoring of packaged HVAC units, heat pumps and fan coil units. This controller provides 8 universal inputs and 8 Form C relay outputs.

- <u>LCX 800I</u>: This controller is a scaled down version of the LCX 800. It has 8 universal inputs and no relay outputs.

- LCX 810: This is a standalone, programmable microprocessor-based controller used for DDC and monitoring of packaged HVAC units, heat pumps and coil units. It has 8 universal inputs, 8 Form C relay outputs and contains an I/O expansion port.

- Eclipse CX9400 Central Processing Unit: The CX9400 is the CPU board for the Eclipse family of controllers and the system coordinator for all distributed Infinity Infinet controllers. This system is available with either 4 or 8 I/O slots. The following I/O modules are available with this system:
  - UI-32-12: Provides 32 universal inputs, which are software configurable, as either thermistor, digital, voltage or counter point types.
  - UI-16-12: Provides 16 universal inputs and the same point type selection as the UI-32-12.
  - UI-32-16: Provides 32 universal inputs, which are software configurable, as either voltage, current, thermistor, 1000 ohm RTD, digital and counter point types.
  - UI-16-16: Provides 16 universal inputs and the same point type selection as the UI-32-16.

Andover Controls has two versions of software, Continuum CyberStation Workstation Software and SX 8000 Front End Software. Continuum CyberStation Workstation Software is a Microsoft Windows NT-based graphical user interface. This software provides the means to control and monitor HVAC, lighting, access and process systems. Continuum stores all facility data in a single Microsoft ODBC-compliant SQL database. SX 8000 Front End Software is designed for single-user and multi-user applications in direct connect and remote communications. SX 8000 Front End supports leading network operating systems such as Microsoft Windows NT Server and Microsoft OS/2 LAN Manager and features the Microsoft SQL database server software. High-resolution graphics assist with control of a building's HVAC, lighting, and access control and process systems. For more information, please contact Andover Controls representatives.

Step 2: Verify the firmware release and hardware/software compatibility

As a general rule for Infinity and Continuum systems, the revision of the workstation software must match the revision of the network-level controllers at least to the first place after the decimal. For example, on an Infinity system, if the SX 8000 front-end is at revision 2.175 and the CX 9200 controller is at revision 2.17, then they are compatible. On the Infinet field bus, the rules are more relaxed such that multiple revisions of the same controller can co-exist on the same Infinet.

SX 8000 Front-End and Continuum CyberStation are only two types of software offered from Andover since 1994. Table 2 lists the software revision numbers and date released for these two types of software and the compatible controllers for each. In general, upgrading the revisions to the current revision throughout a system is recommended as each new revision includes enhancements and problem fixes. For more information, please contact Andover Controls representatives.

Table 2. Andover Controls Product Revision History

Software: SX 8000 Front-End		**Software: Continuum CyberStation**	
Compatible Controllers: **Eclipse (CX 9400)** **CX 9200** **CMX 240** **CMX 220**		**Compatible Controllers:** **NetController (CX 9900)** **Eclipse (CX 9400)** **CX 9200** **CMX 9924**	
Revision Number	Revision Date:	Revision Number	Revision Date
Rev 1.6	Jan 1994	Rev 1.0	Dec 1998
Rev 1.7	Oct 1994	Rev 1.1	June 1999
Rev 2.0	July 1995	Rev 1.2	Aug 1999
Rev 2.1	Dec 1995	Rev 1.3	Dec 2000
		Rev 1.4	Sept 2001

Step 3: Use Table 3 to find the general specification of the controller and the input type for each controller

The four input types included for analog inputs are current, voltage, thermistor and platinum RTD. The digital input type requires the input to have a counter or accumulator feature. For example, if SCX 920 is used to monitor room temperature, we can conclude from Table 3 that a voltage, current or thermistor type temperature sensor can be used with this controller. This will help select the correct sensor.

Table 3. Andover Controls Hardware Specification

Model	Analog Input				Digital Input	
	Current	Voltage	Thermistor	Platinum RTD	Digital	Counter
Continuum I/O Module UI-8-10	N/A	0-5 V DC Accuracy: ± 15 mV	10 KΩ, type III Accuracy: ± 1°F Over 40-100°F range	N/A	N/A	
Continuum I/O Module DI-8	N/A	N/A	N/A	N/A	Contact Closure High Speed Counting (channel 1,2 in Hi Speed Mode) Freq.: 10 kHz Pulse Width: 50 µs Low Speed Counting (channel 3-8 and 1,2 in Lo Speed Mode) Freq.: 10 Hz Pulse Width: 50 ms	
Continuum I/O module MI-6	0-20 mA Accuracy: ± 80µA	N/A	N/A	N/A	N/A	
SCX 920	0-20 mA Accuracy: ± 30µA	0-10 V DC Accuracy: ± 5 mV	10 KΩ Accuracy: ± 0.46°F Over –10 to 150°F	N/A	Contact Closure Freq.: 5 Hz (max) Pulse Width: 100 ms (min)	

Table 3. Andover Controls Hardware Specification (continued)

Model	Analog Input				Digital Input	
	Current	**Voltage**	**Thermistor**	**Platinum RTD**	**Digital**	**Counter**
LCX 800/800I	0-20 mA Accuracy: ± 80µA	0-5 V Accuracy: ± 15 mV	10 KΩ Accuracy: ± 1.5°F Span: –10 to 150°F	N/A	Contact Closure Freq.: 4 Hz (max) Pulse Width: 125 ms (min)	
LCX 810	0-20 mA Accuracy: ± 30µA	0-10 V Accuracy: ± 2.5 mV	10 MΩ Accuracy: ± 0.46°F Span: –10 to 150°F	N/A	Contact Closure Freq.: 4 Hz (max) Pulse Width: 125 ms (min)	
Eclipse I/O module UI-16-12, UI-16-16,UI-32-12 or UI-32-16	0-20 mA Accuracy: ± 30µA Only on UI-16-16 and UI-32-16	0-10 V Accuracy: ± 5 mV	10 MΩ Accuracy: ± 0.26°F Span: –10 to 100°F	1000 Ω RTD Accuracy: ± 0.45°F over –328 to 122°F Only on UI-16-16 and UI-32-16	Contact Closure Freq.: 5 Hz (max) Pulse Width: 100 ms (min)	
Eclipse I/O module DI-32-DRY	N/A	N/A	N/A	N/A	Contact Closure Freq.: 5 Hz (max) Pulse Width: 100 ms (min)	

Step 4: Check data logging performance of controller

Once the existing controller is identified, use Table 4 to check for acceptable data logging performance of the controller for each monitoring parameter: electrical consumption, thermal consumption and room temperature. Table 4 provides recommendations in the event the existing controller cannot be used to monitor a parameter.

Table 4. Andover Controls Hardware and Monitoring Capabilities Compatibility

	Electrical Consumption		**Thermal Consumption**		**Room Temperature**
Sensor Device Output	Digital	Analog	Digital	Analog	Analog
Continuum NetController with I/O module	•	•	•	•	•
SCX 920	•	•	•	•	•
LCX 800/800I	•	•	•	•	•
LCX 810	•	•	•	•	•
Eclipse 9400 with I/O module	•	•	•	•	•

- Indicates acceptable performance for logging a point type

Step 5: Upgrade EMCS for data logging

The suitability of the existing EMCS equipment should now be determined so that any needed upgrades can be accomplished. For example, if a remote panel needs to be upgraded to improve the accuracy, this should be done before continuing with the set-up procedures in Chapter 3.

After establishing the compatibility and type of parameter to be monitored and logged and after knowing which type of meter or calculation to be used, the set-up procedures can be selected.

The following application set-up procedures are outlined in Chapter 3 for specific functions:

- Electrical Consumption and Demand Monitoring Using Watt Hour Transducer (digital input)
- Electrical Consumption and Demand Monitoring Using Watt Transducer (analog input)
- Thermal Consumption Monitoring Using BTU Meter
- Thermal Consumption Monitoring Using EMCS
- Room Temperature Monitoring

CHAPTER 3. APPLICATION SET-UP PROCEDURES

The following procedures and charts provide the requirements to enable existing controllers to perform specified functions. These procedures are covered in detail in Chapter 3.

Application A. Electrical Consumption and Demand Monitoring Using a Watt-Hour Transducer.
Application B. Electrical Consumption Monitoring Using a Watt Transducer.
Application C. Thermal Consumption Monitoring Using a BTU Meter.
Application D. Thermal Consumption Monitoring Using an EMCS.
Application E. Room Temperature Monitoring.
Application F. Configure For Data Collection and Storage in Continuum CyberStation Workstation Software.

Application A. Electrical Consumption and Demand Monitoring Using a Watt Hour Transducer

Application A provides the user with steps to follow in setting up a Watt Hour Transducer to monitor electrical consumption and demand. By following these steps, the user will enable the EMCS to measure electrical consumption (kWh) and store fifteen-minute data. Chart A-1 lists the needed equipment and helps determine if the controller has an available input slot. Chart A-2 aides the user in choosing a Watt Hour Transducer (WHT) and a Current Transducer (CT). For the different controller models, the chart lists the accuracy, pulse widths and pulse rates the WHT and CT must contain, and wire and sensor specifications. Some tips for CT installation are provided as well. Chart A-3 provides an example of a WHT and a CT available in the market. Chart A-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly consumption and record 15-minute consumption. The user should then proceed to Application F to set-up the data collection and history data storage.

Step 1. Check the input slot availability on the controller.

Use Chart A-1 to find which slots are needed on the controller. The position of the slot can be found in Chart A-1 under Controller Terminal Connections. For example, the Continuum NetController with UI-8-10 needs an available slot on the IN 1-8 terminal blocks. If slots are available on any of these, the procedure can be followed. If there are no available slots, contact an Andover Controls representative to check whether an expansion I/O module can be added to this controller or if an additional controller needs to be installed.

Step 2. Choose a Watt Hour Transducer (WHT) and Current Transducer (CT).

Chart A-2 lists the WHT and CT specifications. For example, an acceptable Watt Hour Transducer for NetController with UI-8-10 should have discrete output with ± 0.5% accuracy or better and a 125 ms minimum pulse width at a 4 Hz maximum pulse rate.

With matching CT output and accuracy selection of ± 1% or better, the end-to-end accuracy from the transducers to the NetController with UI-8-10 could be around ± 1.5%.

Chart A-3 shows an example of a WHT and a CT provided in the market.

Step 3. Follow the EMCS programming steps.

Chart A-4 provides the steps to set-up the external input point from the transducer and the internal points to store the consumption value the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point and internal points.

Step 4. Follow the steps in Application F.

Application F lists the steps to set-up the data collection and history data storage.

After the steps are complete, the system will then be usable to collect monthly consumption and record 15-minute demand.

Chart A-1. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

Verify that the controller has the available slots as discussed below. Also, the terminal connections on the controller need to have the resistors connected as specified below.

	Continuum NetController with UI-8-10	**Continuum NetController with DI-8**	**SCX 920**	**LCX 800/800I**	**LCX 810**	**Eclipse 9400 with UI-xx-yy* or DI-32-DRY**
What is measured	• Electrical consumption of either One-Phase or Three Phase, 208 to 480 VACrms, 50/60 Hz					
What is stored in EMCS	• Fifteen-minute data of electrical consumption in kWh units stored in Trend Data History.					
What is needed	3 - CT sensor 1 - Watt Hour Transducer 1 – available slot on Terminal Block (for external discrete input) 1 – available internal pulse input point (to accumulate month-to-date consumption)					
Controller Terminal Connections	IN 1-8	High Speed Counter: IN 1-2 Low Speed Counter: IN 1-8	IN 1-16	IN 1-8	IN 1-8	IN 1-16 for 16 inputs and IN 1-32 for 32 inputs
DIP Switch Position	Ref. Resistor: ON Voltage Range: 5V (Optional)	For IN 1-2 High Speed Counting, High Speed Counter: ON	Ref. Resistor: IN	N/A	Ref. Resistor: IN	Current Sense Resistor: OFF Or Pull-up Resistor: ON

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

Chart A-2. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

Watt Hour Transducer and Current Transducer Specifications

	Continuum NetController with UI-8-10	Continuum NetController with DI-8	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy* or DI-32-DRY
Output Type from Watt Hour Transducer	Discrete (each pulse is equal to xxx kWh, varies with specific sensor)					
Maximum Pulse Rate	4 Hz	High Speed Counting:10 kHz and Low Speed Counting: 10 Hz	5 Hz	4 Hz	4 Hz	5 Hz
Minimum Pulse Width	125 ms	High Speed Counting: 50 µs and Low Speed Counting: 50 ms	100 ms	125 ms	125 ms	100 ms
Accuracy from Watt Hour Transducer	± 0.5 % (not including CT's)					
CT Accuracy	± 1.0 %					
Note	CT sensors Output: Match the input type for Watt Hour Transducer Input: Make sure that input current is enough to cover the normal current					
End-to-end Accuracy	± 1.5 %					

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

Next, the specifications for the Watt Hour Transducer must satisfy the input requirements for the controller.

Make sure that the device will cover the peak demand kW, will not generate more pulses than the maximum pulse rate and will maintain the signal pulse width at least for the minimum pulse width duration.

Current transformers have several styles. Split core CTs are easier to install. To ensure these are installed in the correct direction, check the polarity of the current read by the EMCS.

Notes on installation:

- Install CT sensors on the electrical main panel. Follow the manufacturer's instructions.
- Install Watt Hour Transducer and terminate CT sensor outputs at the WHT inputs. Follow the manufacturer's instructions.
- Electrical shock can occur from CT's without a shunt resistor.
- Terminate Watt Hour Transducer output at the Terminal Block. Follow the manufacturer's instructions.

Chart A-3. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

An Example of Watt Hour Transducer Specifications

The following Watt-Hour Transducer has been successfully used.

Watt Hour Transducer		
Ohio Semitronics, Inc.		
WL-3968		
Input	Current	Output from Current Transformer 0 - 0.333 V
	Voltage	120/208 & 277/480
	Phase	Three-Phase, Three-Wire or Three-Phase, Four-Wire
	Range	± 15%
	Burden	None
	Power Factor	0.5 Lead to 0.5 Lag
	Instrument Power	208/240/480, 50/60 Hz, 2.5 Watts
Output	Relay	Dry Contact, 120 V, 0.3 A, 10 VA Max
	Closure Duration	250 Milliseconds
	Accuracy	± 0.5% F.S.
	Isolation	Input/Output/Case 750 VAC
	Temperature Effects	(-20°C to +60°C) ± 0.02%/°C

Chart A-3. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer (continued)

An Example of Current Transducer Specifications

The following Current Transducer has been successfully used.

Current Transducer		
Sentran Corporation		
4LS3 Split Bus Bar		
Input	Current	AC current, sinewave, single phase 60 Hz, Load PF 0.5-1 lead or lag 100, 200, 300, 400, 500, 600, 800, 1K, 1.5K, 2K, 2.5K and 3K Amp
	Voltage rating	600 VAC Tested Per ANSI C57.13 BIL 10 KV AC Full Wave for 60 seconds
	Bandwidth	10 Hz to 1000 Hz ± 3 db
Output	Voltage	100 mV, 250 mV, 333 mV, 500 mV, 1 V and 5 V
	Limiting	20 V AC RMS
	Accuracy	± 1% ratio and linearity accuracy from 5% to 200% of scale
	Phase Displacement	± 1 degree
	Output Resistance	< 100 Ohms
	Interface Resistance	> 10K Ohms
	Lead Wires	20 or 22 AWG UL1015, 600V insulation, 105 C

Chart A-4. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

EMCS Programming Steps

Summary

The following Steps are covered in detail in Chart A-4

Step 1. Set-up external pulse input point in EMCS to accumulate daily consumption for the Wh-to-pulse transducer.

Step 2. Set-up internal output point to accumulate monthly consumption from external point created in Step 1.

Step 3. Create a trend point extension on the internal output point in the EMCS to record the 15-minute accumulated consumption values.

Step 4. Add a programming step to accumulate the counter value created in Step 1 and store in the point created in Step 2.

Details of these steps follow.

Step 1. Set-up an external pulse input (PI) point in EMCS to accumulate daily consumption for Wh-to-pulse transducer.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

a. Connect installed sensors to the controller.
b. From "Menu" page, click "Tool", then "Continuum Explorer".
c. Right click on the controller to which the point will be added.
d. Select "New" from the menu, and then select "InfinityInput".
e. New dialog box will be displayed. Enter the name and alias and click "Create".
f. InfinityInput Editor will be displayed. Set the following parameters as specified below:
   - In "General" Tab,

Value	0 (This value will be shown when this point is not active)
Unit	kWh
Description	Enter a point description up to 32 characters in length
State	Enabled

Continued on Next Page

- In “Setting” Tab,

<table>
<tr><th></th><th>Continuum NetController with UI-8-10</th><th>Continuum NetController with DI-8</th><th>SCX 920</th><th>LCX 800/800I</th><th>LCX 810</th><th>Eclipse 9400 with UI-xx-yy* or DI-32-DRY</th></tr>
<tr><td>ElecType</td><td colspan="6">Counter</td></tr>
<tr><td>Channel</td><td colspan="6">x, x is the terminal connection IN-x. For example, a sensor is installed at IN-5, the channel is 5.</td></tr>
<tr><td>IOU</td><td colspan="2">Number of the Input/Output module that is sending the input</td><td>0</td><td>0</td><td>0</td><td>Number of the Input/Output board on Lbus</td></tr>
<tr><td>Format</td><td colspan="6">###.## (floating point)</td></tr>
<tr><td>Digital Filter</td><td colspan="6">False</td></tr>
</table>

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

- In “Conversions” Tab

Threshold	0.00 (The point will be updated with every change)

Step 2. Set-up internal output point to accumulate monthly consumption from external point created in Step 1.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

a. In Continuum Explorer window, right click on the controller to which the point will be added.
b. Select “New” from the menu, and then select “InfinityNumeric”.
c. New dialog box will be displayed. Enter the name and alias and click “Create”.
d. InfinityNumeric Editor will be displayed. Set the following parameters as specified below:
   - In “General” Tab,

Value	0 (This is the initial value)
Unit	kWh
Description	Enter a point description up to 32 characters in length
Channel and IOU number	(NetControllers only) Enter the channel number as it is marked on the controller. Enter an IOU number.
Direction	IOOutput
State	Enabled
Setpoint	No Check
Format	###.## (2 decimal floating points)

Step 3. Create a trend point extension on the internal output point in the EMCS to record the 15-minute accumulated consumption values.

Continue from Step 2. “InfinityNumeric Editor” window will be displayed. Set the following parameters as specified below:

- In “Logs” Tab, on the left side of the Logs page

Number of Entries	3,500 (3,500 points will be kept at the controller)
Type	LogInstantaneous
Interval	Days: 0 Hours: 0 Minutes: 15 Seconds: 0 (Andover automatic logs always start at the top of the hour, so the data will be recorded every quarter of the hour)

- In “Logs” Tab, on the right side of the Logs page

Number of Entries	17,520 (the maximum amount of numbers that Continuum database will keep)
Interval	Days: 0 Hours: 4 Minutes: 0 Seconds: 0 (Continuum will store new values in the log every four hours)
	Note: To maintain a good data history, a monthly export of data is needed.

Step 4. Add a programming step to accumulate the counter value created in Step 1 and store in the point created in Step 2.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

a. In Plain English Integrated Development Environment, click “New” from the IDE File menu. The Create dialog box will display a list of objects.
b. In Network View, under Device section, select the controller in which this program will be stored.
c. Enter the name of this program, up to 16 characters, in the field marked “Object Name”.
d. Click “Create”, then configure program file attributes.
e. Select “Configuration” from the File menu and fill in the configuration page dialog box.
f. Click “Enabled” state, “Looping” flow type, and check the boxes on “Autostart” and “Command Line”.
g. Select run time page and then click “OK”.
h. New program editor window will be displayed. Enter the program lines to accumulate the electrical consumption (See Appendix A).
i. When complete and before saving a file, make sure the Assistant window is displayed.
j. From File Menu select “Save”. The IDE automatically checks the file for errors before saving. If errors are found, the Check tab on the Assistant window becomes active and lists the errors. The IDE will not save a program file and will not close until all the errors are fixed.

Application B. Electrical Consumption Monitoring Using A Watt Transducer

Charts B-1 through B-4 provide the user with steps to follow in setting up a Watt Transducer to monitor electrical consumption and demand. By following these steps, the user will enable the EMCS to measure electrical consumption (kWh) and store fifteen-minute data. Chart B-1 lists the needed equipment and will help the user determine if the controller has an available input slot. Chart B-2 aids the user in choosing a Watt Transducer (WT) and a Current Transducer (CT). The table lists accuracy, output type, maximum lengths of wire for the WT and CT, and wire and sensor specifications for different controller models. Chart B-3 provides an example of a WT and a CT available in the market. Chart B-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly consumption, display current demand and record 15-minute consumption. The user should then proceed to Application F to set-up the data collection and history data storage.

Step 1. Check the input slot availability on the controller.

Use Chart B-1 to find which slots are needed on the controller. The position of the slot can be found in Chart B-1 under Controller Terminal Connections. For example, Continuum NetController with MI-6 needs an available slot on IN 1-6. If slots are available on either of these the procedure can be followed. If there are no available slots, contact an Andover Controls representative to check whether an expansion I/O module can be added to this controller or if an additional controller needs to be installed.

Step 2. Choose a Watt Transducer (WT) and Current Transducer (CT).

Chart B-2 lists the WT and CT specifications. For example, an acceptable Watt Transducer for NetController with MI-6 should have analog output (preferred current 4-20 mA) with 0.5% accuracy or better. With matching CT output and accuracy selection of 1% or better, the end-to-end accuracy from the transducers to the NetController with MI-6 could be around 1.5%. Note that to gain this accuracy the transducers must be placed no further than 500 ft. away with 18 AWG wire type

Chart B-3 shows an example of a WT that is provided in the market. CT is included in this Watt Transducer example.

Step 3. Follow the EMCS programming steps.

Chart B-4 provides the steps to set-up the external input point from the transducer and the internal points to store the consumption value the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point and internal points.

Step 4. Follow the steps in Application F.

Application F lists the steps to set-up the data collection and history data storage.

After these steps are complete, the system will then be usable to record monthly consumption and display current demand.

Chart B-1. Electrical Consumption Monitoring Using Watt Transducer

Verify that in addition to the sensors and transducer, that the controller has the available slots as discussed below. Also, the terminal connections on the controller need to have the resistors connected as specified below.

	Continuum NetController with UI-8-10	Continuum NetController with MI-6	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy*
What is measured	Electrical consumption of either One-Phase or Three Phase, 208 to 480 VAC rms, 50/60 Hz					
What is stored in EMCS	Fifteen-minute data of Electrical Consumption in kWh units stored in Trend Data History.					
What is needed	3 - CT sensor 1 - Watt Transducer 1 – available slot on Terminal Block (for analog input) 1 – available internal accumulative points for electric consumption					
Controller Terminal Connections**	IN 1-8 (voltage)	IN 1-6 (current)	IN 1-16	IN 1-8	IN 1-8	IN 1-16 for 16 inputs and IN 1-32 for 32 inputs
DIP Switch Position	Ref. Resistor: OFF Voltage Range: 5V for 0-5V Input Range or 10V for 0-10V Input Range (Optional)	N/A	Ref. Resistor: OUT For Current Input: recommended additional resistor across the input, 475 Ω, 0.1% for a 0-20 mA input	For Current Input: recommended additional resistor across the input, 249 Ω, 0.1% for a 0-20 mA input.	Ref. Resistor: OUT For Current Input: recommended additional resistor across the input, 475 Ω, 0.1% for a 0-20 mA input.	Pull-up Resistor: OFF Current Sense Resistor: OFF for voltage input, ON for current input (Optional)

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

** Controller Terminal Connections for analog inputs, both current and voltage inputs, otherwise stated.

Chart B-2. Electrical Consumption Monitoring Using Watt Transducer

Watt Transducer and Current Transducer Specifications

	Continuum NetController with UI-8-10	Continuum NetController with MI-6	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy*
Output Type from Watt Transducer	Analog, 4-20 mA (preferred) or voltage type					
Accuracy from Watt Transducer	± 0.5 % (not including CT's)					
Maximum Wire Length (ft.)	500 ft. @ 18 AWG wire					
CT Accuracy	± 1.0 %					
Note	CT sensors • Output: Match the input type for Watt Transducer • Input: Make sure that input current is enough to cover the normal current					
End-to-end Accuracy for Current Input	N/A	± (1.5 % reading plus 0.5% range)	± (1.5 % reading plus 0.2% range)	± (1.5 % reading plus 0.5% range)	± (1.5 % reading plus 0.2% range)	± (1.5 % reading plus 0.2% range)
End-to-end Accuracy for Voltage Input	± (1.5 % reading plus 0.3% range)	N/A	± (1.5 % reading plus 0.05% range)	± (1.5 % reading plus 0.3% range)	± (1.5 % reading plus 0.03% range)	± (1.5 % reading plus 0.05% range)

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

Next, the specifications for the Watt Transducer must satisfy the input requirements for the controller. Make sure that the device will cover the peak demand kW. An example of the available Watt Transducer is shown in the next chart. The Current Transducer is already included in this example.

Chart B-3. Electrical Consumption Monitoring Using Watt Transducer

Example Watt Transducer Specifications

Watt Transducer (CT included)		
Veris Industries, Inc.		
H-8040		
Input	Primary Voltage	208 or 480 VAC rms
	Phase	One-Phase or Three-Phase
	Primary Current	Up to 2400 amps cont. per phase
Output	Type	4 – 20 mA
	Supply Power	9 – 30 V dc; 30 mA max
	Accuracy	± 1%
	Internal Isolation	2000 VAC rms
	Case Insulation	600 VAC rms
	Current Transformer	Split core, 100, 300, 400, 800, 1600 or 2400 amps

Chart B-4. Electrical Consumption Monitoring Using Watt Transducer

EMCS Programming Steps

Summary

1. Set-up external analog input point in EMCS to store demand from Watt transducer.
2. Set-up internal analog point to accumulate monthly consumption from external point created in Step 1.
3. Create Trend point extension on internal analog output point in EMCS to record 15-minute accumulated consumption values.
4. Add a programming step to accumulate the point value created in Step 1 and store in the point created in Step 2.

Details of these steps follow.

Step 1. Set-up external analog input point in EMCS to store demand from Watt transducer.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

a. Connect installed sensors to the controller.
b. From "Menu" page, click "Tool", then "Continuum Explorer".
c. Right click on the controller to which the point will be added.
d. Select "New" from the menu, and then select "InfinityInput".
e. New dialog box will be displayed. Enter the name and alias and click "Create".
f. InfinityInput Editor will be displayed. Set the following parameters as specified below:
   - In "General" Tab,

Value	0 (This value will be shown when this point is not active)
Unit	kW
Description	Enter a point description up to 32 characters in length
State	Enabled

Continued on Next Page

- In “Setting” Tab,

	Continuum NetController with UI-8-10	Continuum NetController with MI-6	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy*
ElecType	Voltage	InputCurrent	InputCurrent for current sensor or Voltage for current/voltage sensor			
Channel	x, x is the terminal connection IN-x. For example, a sensor is installed at IN-5, the channel is 5.					
IOU	Number of the Input/Output module that is sending the input		0	0	0	Number of the Input/Output board on Lbus
Format	###.## (floating point)					
Digital Filter	False					

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

- In “Conversions” Tab

Threshold	0.00 (The point will be updated with every change)
Auto Conversion	Top kW: the kW value corresponding to the high signal from sensor Top Current: 20 mA Bottom kW: the kW value corresponding to the low signal from sensor Bottom Current: 4 mA For instance, Watt Transducer is set-up to send out signal 0 kW demand at 4 mA and 500 kW demand at 20 mA. The bottom value in this case is 0 and the top value is 500.
	• Click “OK”

Step 2. Set-up internal analog point to accumulate monthly consumption from external point created in Step 1.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

a. In Continuum Explorer window, right click on the controller to which the point will be added.
b. Select "New" from the menu, and then select "InfinityNumeric".
c. New dialog box will be displayed. Enter the name and alias and click "Create".
d. InfinityNumeric Editor will be displayed. Set the following parameters as specified below:
   - In "General" Tab,

Value	0 (This is the initial value)
Unit	kWh
Description	Enter a point description up to 32 characters in length
Channel and IOU number	(NetControllers only) Enter the channel number as it is marked on the controller. Enter an IOU number.
Direction	IOOutput
State	Enabled
Setpoint	No Check
Format	###.## (2 decimal floating points)

Step 3. Create trend point extension on internal analog output point in EMCS to record 15-minute accumulated consumption values.

Continue from Step 2. "InfinityNumeric Editor" window will be displayed. Set the following parameters as specified below:

- In "Logs" Tab, on the left side of the Logs page

Number of Entries	3,500 (3,500 points will be kept at the controller)
Type	LogInstantaneous
Interval	Days: 0 Hours: 0 Minutes: 15 Seconds: 0 (Andover automatic logs always start at the top of the hour, so the data will be recorded every quarter of the hour)

- In "Logs" Tab, on the right side of the Logs page

Number of Entries	17,520 (the maximum amount of numbers that the Continuum database will keep)
Interval	Days: 0 Hours: 4 Minutes: 0 Seconds: 0 (Continuum will store new values in the log every four hours)
	Note: To maintain a good data history, a monthly export of data is needed.

Step 4. Add a programming step to accumulate the point value created in Step 1 and store in the point created in Step 2.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

a. In Plain English Integrated Development Environment, click "New" from the IDE File menu. The Create dialog box will display a list of objects.
b. In Network View, under Device section, select the controller in which this program will be stored.
c. Enter the name of this program, up to 16 characters, in the field marked "Object Name".
d. Click "Create", then configure program file attributes.
e. Select "Configuration" from the File menu and fill in the configuration page dialog box.
f. Click "Enabled" state, "Looping" flow type, and check the boxes on "Autostart" and "Command Line".
g. Select run time page and then click "OK".
h. New program editor window will be displayed. Enter the program lines to accumulate the electrical consumption from electrical demand (See Appendix A).
i. When complete and before saving a file, make sure the Assistant window is displayed.
j. From File Menu select "Save". The IDE automatically checks the file for errors before saving. If errors are found, the Check tab on the Assistant window becomes active and lists the errors. The IDE will not save a program file and will not close until all the errors are fixed.

Application C. Thermal Consumption Monitoring Using a BTU Meter

Charts C-1 through C-4 provide the user with steps to follow in setting up a BTU meter to monitor thermal consumption. By following these steps, the user will enable the EMCS to measure thermal consumption (MMBTU) and store fifteen-minute data. Chart C-1 lists the needed equipment and will help the user determine if the controller has an available input slot. Chart C-2 aids the user in choosing a BTU meter, temperature sensors and a flow meter. The chart lists the BTU meter, temperature sensor, and flow meter accuracy for the different controller models. The chart also lists output type, pulse widths and pulse rates the BTU meter must have. Some tips for BTU meter selection and flow meter installation are provided as well. Chart C-3 provides an example of a BTU meter, a temperature sensor and a flow meter available in the market. Chart C-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly thermal consumption and record 15-minute thermal consumption. The user should then proceed to Application F to set-up the data collection and history data storage.

Step 1. Check the input slot availability on the controller.

Use Chart C-1 to find which slots are needed on the controller. The position of the slot can be found in Chart C-1 under Controller Terminal Connections. For example, SCX 920 needs an available slot on IN 1-16. If slots are available on either of these the procedure can be followed. If there are no available slots, contact an Andover Controls representative to check whether an expansion I/O module can be added to this controller or if an additional controller needs to be installed.

Step 2. Choose a BTU Meter, Temperature Sensor and Flow Meter.

Chart C-2 lists the BTU meter, temperature sensor and flow meter specifications. For example, an acceptable BTU meter for SCX 920 should have discrete output with at least 100 ms pulse width at 5 Hz maximum pulse rate. This BTU meter should be installed with matching temperature sensors and flow meter output at the recommended accuracy. The end-to-end accuracy of this thermal measurement does not depend only on the meter and sensors but also the characteristics of the system (differential temperature). Chart C-2 and Appendix B provide more information about this.

Chart C-3 shows examples of a BTU meter, temperature sensors and a flow meter provided in the market.

Step 3. Follow the EMCS programming steps.

Chart C-4 provides the steps to set-up the external input point (from the BTU Meter) the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point and internal points.

Step 4. Follow the steps in Application F.

Application F lists the steps to set-up the data collection and history data storage.

After these steps are complete, the system will be usable to collect and store monthly thermal consumption data.

Chart C-1. Thermal Consumption Monitoring Using a BTU Meter

Verify that in addition to the sensors and transducer, that the controller has the available slots as discussed below. Also, the terminal connections on the controller need to have the resistors connected as specified below.

	Continuum NetController with UI-8-10	Continuum NetController with DI-8	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy* or DI-32-DRY
What is measured	• Chilled/Hot water flow • Chilled/Hot water supply and return temperature					
What is stored in EMCS	• Fifteen-minute data of Thermal Consumption in MMBtu units stored in Trend Data History					
What is needed	1 – Flow meter 2 – Temperature sensors 1 – BTU meter 1 – available slot on Terminal Block (for digital input)					
Controller Terminal Connections	IN 1-8	High Speed Counter: IN 1-2 Low Speed Counter: IN 1-8	IN 1-16	IN 1-8	IN 1-8	IN 1-16 for 16 inputs and IN 1-32 for 32 inputs
DIP Switch Position	Ref. Resistor: ON Voltage Range: 5V (Optional)	For IN 1-2 High Speed Counting, High Speed Counter: ON	Ref. Resistor: IN	N/A	Ref. Resistor: IN	Current Sense Resistor: OFF or Pull-up Resistor: ON

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

Chart C-2. Thermal Consumption Monitoring Using a BTU Meter

BTU Meter, Flow Meter and Temperature Sensor Specifications

	Continuum NetController with UI-8-10	**Continuum NetController with DI-8**	**SCX 920**	**LCX 800/800I**	**LCX 810**	**Eclipse 9400 with UI-xx-yy* or DI-32-DRY**
Output Type from BTU Meter	Digital Pulse (each pulse is equal to xxx MMBTU, varies with specific meter)					
Maximum Pulse Rate	4 Hz	High Speed Counting:10 kHz and Low Speed Counting: 10 Hz	5 Hz	4 Hz	4 Hz	5 Hz
Minimum Pulse Width	125 ms	High Speed Counting: 50 µs and Low Speed Counting: 50 ms	100 ms	125 ms	125 ms	100 ms
Accuracy from Flow Meter	Recommended Accuracy for flow meter is ± 1% full scale					
Accuracy from Temperature Sensor	Recommended Accuracy: ± 0.2 °F for chilled water temperature sensors and ± 0.5 °F for hot water temperature sensors.					
End-to-end Accuracy	Depends on the accuracy of the temperature sensor, flow meter and how large the temperature difference is. Assuming the difference between chilled water supply and return temperature is 10 °F, the end-to-end accuracy can approach 5%. Assuming the difference between hot water supply and return temperature is 20 °F, the accuracy can approach 7%, without end-to-end calibration. See Appendix B					

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

Tips on BTU Meter selection:

- Make sure that the BTU meter will cover the peak BTU, will not generate pulses more than the maximum pulse rate and will maintain the output pulse signal with at least the minimum pulse width duration.
- Use matched temperature sensors.
- Temperature sensor and flow meter outputs are correct for the BTU meter inputs.
- The specifications for the BTU Meters must satisfy the input requirements for the controller.

Notes on installation:

- Install the flow meter in either the supply or return pipe.
- Install matched temperature sensors, one on the supply pipe and another sensor on the return pipe.
- For the temperature sensor on the same pipe as the flow meter, install the sensor close to the flow meter.
- Disconnect the flow meter and temperature sensors at the BTU meter input board. Follow the manufacturer's instructions.
- Disconnect the BTU meter output at the terminal block. Follow the manufacturer's instructions.

Chart C-3. Thermal Consumption Monitoring Using a BTU Meter

Example BTU Meter, Flow Meter and Temperature Sensor Specifications

The following BTU meter, flow meter and temperature sensors have been successfully used.

BTU Measurement System		
Keegan Electronics, Inc.		
System 90 Series		
Input	Temperature	2 matched temperature sensors supplied by Keegan Electronics
	Minimum Resolution of Temperature reading	0.1°C
	Flow	1 flow sensor supplied by Data Industrial
	Minimum Closure Duration	2 milliseconds
	Maximum Length of cable	500 feet
	Electrical	Connect to high voltage (120 V AC) through a circuit breaker
Output	Standard Output	Monostable relay outputs, SPST, 2A @ 120 V AC resistive representing BTU's and Gallons
	Optional Output	0-1 mA DC or 4-20 mA DC representing instantaneous BTU/Hr and GPM
	Accuracy	Depends on the accuracy of temperature sensor, flow meter and how large the temperature difference is.

Chart C-3. Thermal Consumption Monitoring Using a BTU Meter (continued)

Example BTU Meter, Flow Meter and Temperature Sensor Specifications

Temperature Sensor		
Keegan Electronics, Inc.		
RTD for System 90 Series		
Input	Temperature Range	0-100 °C
Output	Standard Output	RTD – variable resistance
	Reference	@ 0°C – output is equal to 32,654 ohms @ 100°C – output is equal to 679 ohms
	Accuracy	± 0.2 °C

Flow Sensor		
Data Industrial		
220 PVCS Insert Flow Sensor		
Input	Flow Rate	1 to 30 ft./sec
	Maximum Pressure	100 psi @ 68°F
	Maximum Temperature	140°F @ 40 psi
	Maximum Length of cable	20 feet shielded twisted pair AWG 20
Output	Standard Output	Voltage pulse, 5V or greater
	Accuracy	± 1% of Full Scale (over recommended design flow range)
	Absolute Accuracy	± 4% of reading within calibration range
	Linearity	± 1%
	Frequency	3.2 – 200 Hz
	Pulse Width	5 milliseconds ± 25%

Chart C-4. Thermal Consumption Monitoring Using a BTU Meter

EMCS Programming Steps

Summary

1. Set-up an external pulse input point in EMCS to accumulate daily consumption for the BTU Meter.
2. Set-up an internal output point to accumulate monthly consumption from the external point created in Step 1.
3. Create a trend point extension on the internal output point in the EMCS to record the 15-minute accumulated consumption values.
4. Add a programming step to accumulate the counter value created in Step 1 and store in the point created in Step 2.

Details of these steps follow.

Step 1. Set-up an external pulse input point in EMCS to accumulate daily consumption for the BTU Meter.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

a. Connect installed sensors to the controller .
b. From “Menu” page, click “Tool”, then “Continuum Explorer”.
c. Right click on the controller to which the point will be added.
d. Select “New” from the menu, and then select “InfinityInput”.
e. New dialog box will be displayed. Enter the name and alias and click “Create”.
f. InfinityInput Editor will be displayed. Set the following parameters as specified below:
    - In “General” Tab,

Value	0 (This value will be shown when this point is not active)
Unit	MMBtu
Description	Enter a point description up to 32 characters in length
State	Enabled

Continued on Next Page

In "Setting" Tab,

	Continuum NetController with UI-8-10	**Continuum NetController with DI-8**	**SCX 920**	**LCX 800/800I**	**LCX 810**	**Eclipse 9400 with UI-xx-yy* or DI-32-DRY**
ElecType	Counter					
Channel	x, x is the terminal connection IN-x. For example, a sensor is installed at IN-5, the channel is 5.					
IOU	Number of the Input/Output module that is sending the input		0	0	0	Number of the Input/Output board on Lbus
Format	###.## (floating point)					
Digital Filter	False					

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

- In "Conversions" Tab

Threshold	0.00 (The point will be updated with every change)

Step 2. Set-up internal output point to accumulate monthly consumption from the external point created in Step 1.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

a. In Continuum Explorer window, right click on the controller to which the point will be added.
b. Select "New" from the menu, and then select "InfinityNumeric".
c. New dialog box will be displayed. Enter the name and alias and click "Create".
d. InfinityNumeric Editor will be displayed. Set the following parameters as specified below:
   - In "General" Tab,

Value	0 (This is the initial value)
Unit	MMBTU
Description	Enter a point description up to 32 characters in length
Channel and IOU number	(NetControllers only) Enter the channel number as it is marked on the controller. Enter an IOU number.
Direction	IOOutput
State	Enabled
Setpoint	No Check
Format	###.## (2 decimal floating points)

Step 3. Create a trend point extension on the internal output point in the EMCS to record the 15-minute accumulated consumption values.

Continue from Step 2. “InfinityNumeric Editor” window will be displayed. Set the following parameters as specified below:

- In “Logs” Tab, on the left side of the Logs page

Number of Entries	3,500 (3,500 points will be kept at the controller)
Type	LogInstantaneous
Interval	Days: 0 Hours: 0 Minutes: 15 Seconds: 0 (Andover automatic logs always start at the top of the hour, so the data will be recorded every quarter of the hour)

- In “Logs” Tab, on the right side of the Logs page

Number of Entries	17,520 (the maximum amount of numbers that the Continuum database will keep)
Interval	Days: 0 Hours: 4 Minutes: 0 Seconds: 0 (Continuum will store new values in the log every four hours)
	Note: To maintain a good data history, a monthly export of data is needed.

Step 4. Add a programming step to accumulate the counter value created in Step 1 and store in the point created in Step 2.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

a. In Plain English Integrated Development Environment, click “New” from the IDE File menu. The Create dialog box will display a list of objects.
b. In Network View, under Device section, select the controller in which this program will be stored.
c. Enter the name of this program, up to 16 characters, in the field marked “Object Name”.
d. Click “Create”, then configure program file attributes.
e. Select “Configuration” from the File menu and fill in the configuration page dialog box.
f. Click “Enabled” state, “Looping” flow type, and check the boxes on “Autostart” and “Command Line”.
g. Select run time page and then click “OK”.
h. New program editor window will be displayed. Enter the program lines to accumulate the thermal consumption (See Appendix A).
i. When complete and before saving a file, make sure the Assistant window is displayed.
j. From File Menu select “Save”. The IDE automatically checks the file for errors before saving. If errors are found, the Check tab on the Assistant window becomes active and lists the errors. The IDE will not save a program file and will not close until all the errors are fixed.

Application D. Thermal Consumption Monitoring Using an EMCS

Charts D-1 through D-4 provide the user with steps to follow in setting up an EMCS to monitor thermal consumption. By following these steps, the user will enable the EMCS to measure thermal consumption (MMBTU) and store fifteen-minute data. Chart D-1 lists the needed equipment and will help the user determine if the controller has an available input slot. Chart D-2 aids the user in choosing temperature sensors and a flow meter. Thechart lists the temperature sensor and flow meter accuracy and output type. Some tips for temperature sensor and flow meter installation are provided as well. Chart D-3 provides an example of a temperature sensor and a flow meter available in the market. Chart D-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly thermal consumption and record 15-minute thermal consumption. The user should then proceed to Application F to set-up the data collection and history data storage.

Step 1. Check the input slot availability on the controller.

Use Chart D-1 to find which slots are needed on the controller. The position of the slot can be found in Chart D-1 under Controller Terminal Connections. For example, LCX 810 needs an available slot on IN 1-8. If slots are available on either of these the procedure can be followed. If there are no available slots, contact an Andover Controls representative to check whether an expansion I/O module can be added to this controller or if an additional controller needs to be installed.

Step 2. Choose a Temperature Sensor and Flow Meter.

Chart D-2 lists the temperature sensor and flow meter specifications. For example, an acceptable temperature sensor and flow meter for LCX 810 should have analog output, either current or voltage output. The end-to-end accuracy of this thermal measurement does not depend only on the meter and sensors but also the characteristics of the system (differential temperature). Chart D-2 and Appendix B provide more information on this.

Chart D-3 shows an example of temperature sensors and flow meter provided in the market.

Step 3. Follow the EMCS programming steps.

Chart D-4 provides the steps to set-up the external input point (from the temperature sensor and flow meter) and internal points used to store the consumption that the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point and internal points.

Step 4. Follow the steps in Application F.

Application F lists the steps to set-up the data collection and history data storage.

After these steps are complete, the system will be usable to collect and store monthly thermal consumption data.

Chart D-1. Thermal Consumption Monitoring Using an EMCS

Verify that in addition to the sensors and transducer, that the controller has the available slots as discussed below. Also, the terminal connections on the controller need to have the resistors connected as specified below.

<table>
<tr><th></th><th>Continuum NetController with UI-8-10</th><th>Continuum NetController with MI-6</th><th>SCX 920</th><th>LCX 800/800I</th><th>LCX 810</th><th>Eclipse 9400 with UI-xx-yy*</th></tr>
<tr><td>What is measured</td><td colspan="6">• Chilled/Hot water flow
• Chilled/Hot water supply and return temperature</td></tr>
<tr><td>What is stored in EMCS</td><td colspan="6">• Fifteen-minute data of Thermal Consumption in MMBTU units stored in Trend Data History</td></tr>
<tr><td>What is needed</td><td colspan="6">1 – Flow meter
2 – Temperature sensors
3 – available slots on Terminal Block (for analog input from flow meter and temperature sensors)
2 – available internal points
• 1 – available internal analog output point (to calculate for instantaneous thermal consumption)
• 1 – available internal pulse input point (to accumulate month-to-date consumption)</td></tr>
<tr><td>Controller Terminal Connections**</td><td>IN 1-8 (voltage)</td><td>IN 1-6 (current)</td><td>IN 1-16</td><td>IN 1-8</td><td>IN 1-8</td><td>IN 1-16 for 16 inputs and IN 1-32 for 32 inputs</td></tr>
<tr><td>DIP Switch Position</td><td>Ref. Resistor: OFF

Voltage Range: 5V for 0-5V Input Range or 10V for 0-10V Input Range (Optional)</td><td>N/A</td><td>Ref. Resistor: OUT

For Current Input: recommended additional resistor across the input, 475 Ω for a 0-20 mA input</td><td>For Current Input: recommended additional resistor across the input, 249 Ω for a 0-20 mA input.</td><td>Ref. Resistor: OUT

For Current Input: recommended additional resistor across the input, 475 Ω for a 0-20 mA input.</td><td>Pull-up Resistor: OFF

Current Sense Resistor: OFF for voltage input, ON for current input (Optional)</td></tr>
</table>

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

** Controller Terminal Connections for analog inputs, both current and voltage inputs, otherwise stated.

Chart D-2. Thermal Consumption Monitoring Using an EMCS

Flow Meter and Temperature Sensor Specifications

	Continuum NetController with UI-8-10	Continuum NetController with MI-6	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy*
Output Type from Flow Meter	Analog, either voltage or current (preferred) output					
Output Type from Temperature Sensors	Analog, current output					
Maximum Wire Length (ft.)	500 ft. @ 18 AWG wire					
End-to-end Accuracy	End-to-end accuracy depends on the accuracy of temperature sensor, flow meter and how large the temperature difference is. Assuming the difference between chilled water supply and return temperature is 10 °F, the end-to-end accuracy can approach 5%. Assuming the difference between hot water supply and return temperature is 20 °F, the accuracy can approach 7%, without end-to-end calibration. See Appendix B					
Note	• Recommended accuracy for temperature sensor: ± 0.2 °F of full scale for chilled water temperature sensors and ± 0.5 °F of full scale for hot water temperature sensor • Recommended accuracy for flow meter: ± 1% of full scale • Temperature sensors should be matched					

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

Notes on installation:

- Install the flow meter in either the supply or return pipe.
- Install matched temperature sensors, one on the supply pipe and another on the return pipe.
- For the temperature sensor on the same pipe as the flow meter, install the sensor close to the flow meter.
- Disconnect the flow meter and temperature sensors at the Terminal Blocks. Follow the manufacturer's instructions.

Chart D-3. Thermal Consumption Monitoring Using an EMCS

An Example of Flow Meter and Temperature Sensor Specifications

The following Flow Meter and Temperature sensors have been successfully used.

Temperature Sensor		
Minco Products, Inc		
RTD with TempTran transmitter		
Input	Temperature Range	30-80 °F (for chilled water system)
Output	Standard Output	Current, 4-20 mA
	Accuracy	± 0.2 % of span

Flow Meter and Transmitter		
Rosemount		
8705 with the integral mounted type transmitter model 8732		
Input	Flow Rate	0.04 to 30 ft./sec
	Maximum Pressure	285 psi @ 100°F
	Temperature Condition	Natural Rubber Lining: 0 to 185 °F
	Minimum Liquid Conductivity	5 microsiemens/cm
Output	Standard Output	Current, 4-20 mA
	Accuracy	± 0.5% of rate from 1 to 30 ft/sec and from ± 0.005 ft/sec to 0.04 ft/sec

Chart D-4. Thermal Consumption Monitoring Using an EMCS

EMCS Programming Steps

Summary

1. Set-up external analog input points in the EMCS for the flow meter and temperature sensors.
2. Set-up two internal analog points in the EMCS for instantaneous and month-to-date thermal consumption.
3. Create a trend point extension on the internal output point in the EMCS to record the 15-minute accumulated consumption values.
4. Add a programming step to calculate the instantaneous and monthly thermal consumption.

Details of these steps follow.

<u>Step 1. Set-up external analog input points in the EMCS for the flow meter and temperature sensors.</u>

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

a. Connect installed sensors to the controller.
b. From "Menu" page, click "Tool", then "Continuum Explorer".
c. Right click on the controller to which the point will be added.
d. Select "New" from the menu, then select "InfinityInput".
e. New dialog box will be displayed. Enter the name and alias and click "Create".
f. InfinityInput Editor will be displayed. Set the following parameters as specified below:

- In "General" Tab,

Value	0 (This value will be shown when this point is not active)
Unit	gpm
Description	Enter a point description up to 32 characters in length
State	Enabled

- In "Setting" Tab,

<table>
<tr><th></th><th>Continuum NetController with UI-8-10</th><th>Continuum NetController with MI-6</th><th>SCX 920</th><th>LCX 800/800I</th><th>LCX 810</th><th>Eclipse 9400 with UI-xx-yy*</th></tr>
<tr><td>ElecType</td><td>Voltage</td><td>InputCurrent</td><td colspan="4">InputCurrent for current sensor or Voltage for current/voltage sensor</td></tr>
<tr><td>Channel</td><td colspan="6">x, x is the terminal connection IN-x. For example, a sensor is installed at IN-5, the channel is 5.</td></tr>
<tr><td>IOU</td><td colspan="2">Number of the Input/Output module that is sending the input</td><td>0</td><td>0</td><td>0</td><td>Number of the Input/Output board on Lbus</td></tr>
<tr><td>Format</td><td colspan="6">###.## (floating point)</td></tr>
<tr><td>Digital Filter</td><td colspan="6">False</td></tr>
</table>

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

- In "Conversions" Tab

Threshold	0.00 (The point will be updated with every change)
Auto Conversion	Top GPM : the GPM value corresponding to the high signal from sensor Top Current: 20 mA Bottom GPM: the GPM value corresponding to the low signal from sensor Bottom Current: 4 mA For instance, when the flow meter is set-up to send out signal 0 GPM at 4 mA and 900 GPM at 20 mA, the bottom value in this case is 0 and the top value is 900.
	• Click "OK"

Repeat the above step to set-up analog input points for flow meter and temperature sensors.

Step 2. Set-up two internal analog points in the EMCS for instantaneous and month-to-date thermal consumption.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

a. In Continuum Explorer window, right click on the controller to which the point will be added.
b. Select “New” from the menu, then select “InfinityNumeric”.
c. New dialog box will be displayed. Enter the name and alias and click “Create”.
d. InfinityNumeric Editor will be displayed. Set the following parameters as specified below:
   - In “General” Tab,

Value	0 (This is the initial value)
Unit	MMBTU/hr
Description	Enter a point description up to 32 characters in length
Channel and IOU number	(NetControllers only) Enter the channel number as it is marked on the controller. Enter an IOU number.
Direction	IOOutput
State	Enabled
Setpoint	No Check
Format	###.## (floating point)

Repeat the above step to set-up analog point for month-to-date thermal consumption.

Step 3. Create a trend point extension on the internal output point in the EMCS to record the 15-minute accumulated consumption values.

Continue from Step 2. "InfinityNumeric Editor" window will be displayed. Set the following parameters as specified below:

- In "Logs" Tab, on the left side of the Logs page

Number of Entries	3,500 (3,500 points will be kept at the controller)
Type	LogInstantaneous
Interval	Days: 0 Hours: 0 Minutes: 15 Seconds: 0 (Andover automatic logs always start at the top of the hour, so the data will be recorded every quarter of the hour)

- In "Logs" Tab, on the right side of the Logs page

Number of Entries	17,520 (the maximum amount of numbers that Continuum database will keep)
Interval	Days: 0 Hours: 4 Minutes: 0 Seconds: 0 (Continuum will store new values in the log every four hours)
	Note: To maintain a good data history, a monthly export of data is needed

Step 4. Add a programming step to calculate the instantaneous and monthly thermal consumption.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

a. In Plain English Integrated Development Environment, click “New” from the IDE File menu. The Create dialog box will display a list of objects.
b. In Network View, under Device section, select the controller in which this program will be stored.
c. Enter the name of this program, up to 16 characters, in the field marked “Object Name”.
d. Click “Create”, then configure program file attributes.
e. Select “Configuration” from the File menu and fill in the configuration page dialog box.
f. Click “Enabled” state, “Looping” flow type, and check the boxes on “Autostart” and “Command Line”.
g. Select run time page and then click “OK”.
h. New program editor window will be displayed. Enter the program lines to accumulate the thermal consumption from the calculated instantaneous thermal consumption (See Appendix C).
i. When complete and before saving a file, make sure the Assistant window is displayed.
j. From File Menu select “Save”. The IDE automatically checks the file for errors before saving. If errors are found, the Check tab on the Assistant window becomes active and lists the errors. The IDE will not save a program file and will not close until all the errors are fixed.

Application E. Room Temperature Monitoring.

Charts E-1 through E-4 guide the user through steps to follow in setting up a temperature sensor to monitor room temperature. Following these steps will enable the EMCS to measure room temperature (°F) and store fifteen-minute data. Chart E-1 lists the needed equipment and will help the user determine if the controller has an available input slot. Chart E-2 aids the user in choosing a temperature sensor. The chart lists each type of output from sensor accuracy for different controller models. In addition, the chart lists wire and sensor specifications. Chart E-3 provides an example of a temperature sensor available in the market. Chart E-4 provides the EMCS programming steps. By following these steps the user will enable the EMCS to display current temperature and record 15-minute temperature. The user should then proceed to Application F to set-up the data collection and history data storage.

Step 1. Check the input slot availability on the controller.

Use Chart E-1 to find which slots are needed on the controller. The position of the slot can be found in Chart E-1 under Controller Terminal Connections. There are three types of temperature sensor inputs, which are acceptable in most controllers: current, voltage and thermistor. Any of these inputs can be chosen depending on the application. For example, Eclipse 9400 needs an available slot on IN1-16 for 16 inputs module for a thermistor temperature sensor. If there are no available slots please contact an Andover Controls representative to check whether an expansion I/O module can be added to this controller or if an additional controller needs to be installed.

Step 2. Choose a Temperature Sensor.

Chart E-2 lists the temperature sensor specifications. For example, an acceptable temperature sensor for Eclipse 9400 should have analog output with ±1°F accuracy or better. The end-to-end accuracy from the temperature sensor to the Eclipse 9400 controller could be under ±1.5°F. Note that to gain this accuracy the temperature sensor must be placed no further than 500 ft. away with 18 AWG type wire. If this accuracy is not acceptable, a temperature with better accuracy is needed or the controller needs to be replaced.

Chart E-3 shows an example of a temperature sensor provided in the market.

Step 3. Follow the EMCS programming steps.

Chart E-4 provides the steps to set-up the external input point (from the sensor) the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point.

Step 4. Follow the steps in Application F.

Application F lists the steps to set-up the data collection and history data storage.

After these steps are complete, the system will be usable to display the current temperature and record 15-minute temperature data.

Chart E-1. Room Temperature Monitoring

Verify that in addition to the sensors and transducer, that the controller has the available slots as discussed below. Also, the terminal connections on the controller need to have the resistors connected as specified below.

	Continuum NetController with UI-8-10	Continuum NetController with MI-6	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy*
What is measured	• Room Temperature					
What is stored in EMCS	• Fifteen-minute data of room temperature in °F unit stored in Trend Data History					
Needed	1 – Temperature sensor 1 – Available slot on Terminal Block (depends on output type of each device)					
Controller Terminal Connections**	IN 1-8 (thermistor,voltage)	IN 1-6 (current)	IN 1-16	IN 1-8	IN 1-8	IN 1-16 for 16 inputs and IN 1-32 for 32 inputs
DIP Switch Position	For Thermistor, Ref. Resistor: ON Voltage Range: 5V For Voltage, Ref. Resistor: OFF and Voltage Range: 5V for 0-5V Input Range or 10V for 0-10V Input Range (Optional)	N/A	For Thermistor, Ref. Resistor: IN. For current and voltage, Ref. Resistor: OUT For Current Input: recommended additional resistor across the input, 475 Ω for a 0-20 mA input	For Current Input: recommended additional resistor across the input, 249 Ω for a 0-20 mA input.	For Thermistor, Ref. Resistor: IN. For current and voltage, Ref. Resistor: OUT For Current Input: recommended additional resistor across the input, 475 Ω for a 0-20 mA input	Pull-up Resistor: ON for thermistor, OFF for current and voltage Current Sense Resistor: OFF for thermistor and voltage input, ON for current input (Optional)

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

** Controller Terminal Connections for analog inputs, current, voltage and thermistor inputs, otherwise stated.

Chart E-2. Room Temperature Monitoring

Temperature Sensor Specifications

	Continuum NetController with UI-8-10	Continuum NetController with MI-6	SCX 920	LCX 800/800I	LCX 810	Eclipse 9400 with UI-xx-yy*
Output Type from Temperature Sensors	Analog, current, voltage or thermistor output					
Accuracy from Temperature sensor	Recommended accuracy for room temperature sensor ± 1.0 °F. This accuracy can be lower depending on the application used					
End-to-end Accuracy for current output**	N/A	± 1.5 °F	± 1.2 °F	± 1.5 °F	± 1.2 °F	± 1.2 °F
End-to-end Accuracy for voltage output**	± 1.3 °F	N/A	± 1.1 °F	± 1.3 °F	± 1.1 °F	± 1.1 °F
End-to-end Accuracy for thermistor output**	± 2.0 °F	N/A	± 1.5 °F	± 2.5 °F	± 1.5 °F	± 1.3 °F
Maximum Wire Length (ft.)	500 ft. @ 18 AWG wire					

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

** temperature sensor with current, voltage or thermistor output range from 0 to 100 °F

Chart E-3. Room Temperature Monitoring

<u>Example Temperature Sensor Specification</u>

Temperature Sensor		
Vaisala		
HMD 60 Y, Duct Temperature Transmitter		
Input	Temperature Range	-20 to 80 °C
Output	Standard Output	Current, 4-20 mA
	Accuracy	± 0.6 °C over the span
	Linearity	0.1 °C or better

Chart E-4. Room Temperature Monitoring

EMCS Programming Steps

Summary

1. Set-up an external analog input point in the EMCS
2. Create Trend point extension on external analog input point in EMCS to record 15-minute temperature values.

Details of these steps follow.

Step 1. Set-up an external analog input point in the EMCS.

In Continuum™ CyberStation™ Workstation Software, perform the following steps:

a. Connect installed sensors to the controller.
b. From "Menu" page, click "Tool", then "Continuum Explorer".
c. Right click on the controller to which the point will be added.
d. Select "New" from the menu, then select "InfinityInput".
e. New dialog box will be displayed. Enter the name and alias and click "Create".
f. InfinityInput Editor will be displayed. Set the following parameters as specified below:
   - In "General" Tab,

Value	0 (This value will be shown when this point is not active)
Unit	DegF
Description	Enter a point description up to 32 characters in length
State	Enabled

   - In "Setting" Tab,

<table>
<tr><th></th><th>Continuum NetController with UI-8-10</th><th>Continuum NetController with MI-6</th><th>SCX 920</th><th>LCX 800/800I</th><th>LCX 810</th><th>Eclipse 9400 with UI-xx-yy*</th></tr>
<tr><td>ElecType</td><td>Voltage or AccTemp(degF) for Thermistor</td><td>InputCurrent</td><td colspan="4">InputCurrent for current sensor, Voltage for current/voltage sensor or AccTemp(degF) for thermistor</td></tr>
<tr><td>Channel</td><td colspan="6">x, x is the terminal connection IN-x. For example, a sensor is installed at IN-5, the channel is 5.</td></tr>
<tr><td>IOU</td><td colspan="2">Number of the Input/Output module that is sending the input</td><td>0</td><td>0</td><td>0</td><td>Number of the Input/Output board on Lbus</td></tr>
<tr><td>Format</td><td colspan="6">###.## (2 floating points)</td></tr>
<tr><td>Digital Filter</td><td colspan="6">False</td></tr>
</table>

* where xx is the amount of input accepted, 16 or 32 inputs. yy is number of bit in A/D conversion, 12 or 16 bits.

- In “Conversions” Tab

Threshold	0.00 (The point will be updated with every change)
Auto Conversion	Top DegF : the temperature value corresponding to the high signal from sensor Top Current: 20 mA Bottom DegF: the temperature value corresponding to the low signal from sensor Bottom Current: 4 mA For instance, when the temperature sensor is set-up to send out signal 30ºF at 4 mA and 90ºF at 20 mA, the bottom value in this case is 30 and the top value is 90.
	• Click “OK”

Step 2. Create Trend point extension on external analog input point in EMCS to record 15-minute temperature values.

Continue from Step 1. "InfinityNumeric Editor" window will be displayed. Set the following parameters as specified below:

- In "Logs" Tab, on the left side of the Logs page

Number of Entries	3,500 (3,500 points will be kept at the controller)
Type	LogInstantaneous
Interval	Days: 0 Hours: 0 Minutes: 15 Seconds: 0 (Andover automatic logs always start at the top of the hour, so the data will be recorded every quarter of the hour)

- In "Logs" Tab, on the right side of the Logs page

Number of Entries	17,520 (the maximum amount of numbers that Continuum database will keep)
Interval	Days: 0 Hours: 4 Minutes: 0 Seconds: 0 (Continuum will store new values in the log every four hours)
	Note: To maintain a good data history, a monthly export of data is needed

Application F. Data Collection Configuration and Storage In Continuum CyberStation Workstation Software

To maintain the data after the extended log limit is reached, a program can be written to read from the extended log and write to a text file.

In Continuum^{TM} CyberStation^{TM} Workstation Software, perform the following steps:

a. In Plain English Integrated Development Environment, click "New" from the IDE File menu. The Create dialog box will display a list of objects.
b. In Network View, under Device section, select the controller in which this program will be stored.
c. Enter the name of this program, up to 16 characters, in the field marked "Object Name".
d. Click "Create", then configure program file attributes.
e. Select "Configuration" from the File menu and fill in the configuration page dialog box.
f. Click "Enabled" state, "Looping" flow type, and check the boxes on "Autostart" and "Command Line".
g. Select run time page and then click "OK".
h. New program editor window will be displayed. Enter the program lines to retrieve all extended log entries (See Appendix D).
i. When complete and before saving a file, make sure the Assistant window is displayed.
j. From File Menu select "Save", the IDE automatically checks the file for errors before saving. If errors are found, the Check tab on the Assistant window becomes active and lists the errors. The IDE will not save a program file and will not close until all the errors are fixed.

This manual archive is recommended to be performed monthly to maintain data history.

Andover will also provide a logging archiver module, which will be completed in the near future. This archiving option is called "Continuum Reports – Extended Log Archiver" and will provide Automatic Archiver, Manual Archiver and Archived Data Reporter features. Automatic Archiver will provide unattended time scheduled archiving of Extended Log data to externally maintained database files and unattended Extended Log Database table truncation. Manual Archiver will provide the same feature as Automatic Archiver but has to be initiated manually. Archived Data Reporter will retrieve, preview or print the archived data by date range, group and point selection. It can also extract the archived data into Continuum graphing, or CSV file creation for 3rd party application graphing.

APPENDICES

Appendix A: Electrical Consumption Accumulation Program

Appendix B: Thermal Consumption Accuracy

Appendix C: Thermal Consumption Calculation Program

Appendix D: Extended Log Archiving Program

Appendix A: Electrical Consumption Accumulation Program

Electrical demand in the unit of kW is obtained and can be accumulated by this program for electrical consumption. The following formula is used to determine an electrical energy usage.

Scan.cur is the length in seconds of the last interpreter scan to the CURrent SCAN.
Bldg1.kw is the measured electrical demand in kW.
Kw.cur is the CURrent scan electrical demand in kW.
Kw.prev is the PREVious scan electrical demand in kW.
Tot.kwh is the calculated TOTal electrical consumption in kWh.
Scan.prev is the length in seconds of the last interpreter scan and the PREVious SCAN.
Monthly.kwh is the calculated electrical consumption in kWh at the end of each MONTH.
Flag1 is the local variable to determine the new month.

```
NUMERIC MONTHLY.KWH, TOT.KWH, SCAN.CUR, KW.CUR, SCAN.PREV, KW.PREV, FLAG1
SET TOT.KW, KW.PREV, FLAG1 = 0
LINE KWACCUMULATION
       SCAN.CUR = SCAN
       KW.CUR = BLDG1.KW
       TOT.KWH = TOT.KWH + (KW.PREV+KW.CUR)*SCAN.CUR/7200
       KW.PREV = KW.CUR
       SCAN.PREV = SCAN.CUR
       IF (DAYOFMONTH = 28, 30 OR 31) AND TOD = 2359 THEN
              IF MONTH = 2 AND FLAG1 = 0 THEN GOTO RESET
              IF DAYOFMONTH = 30 AND TOD = 2359 THEN
                     IF (MONTH = 4, 6, 9 OR 11) AND FLAG1 = 0 THEN GOTO RESET
              ELSE
                     IF DAYOFMONTH = 31 AND TOD = 2359 THEN
                            IF (MONTH = 1, 3, 5, 7, 8, 10 OR 12) AND FLAG1 = 0 THEN GOTO RESET
                     ENDIF
              ENDIF
       ENDIF
       IF (DAYOFMONTH = 1) AND FLAG1 = 1 THEN
       SET FLAG1 = 0
       ENDIF
       GOTO KWACCUMULATION

LINE RESET
       MONTHLY.KWH = TOT.KWH
       SET FLAG1 = 1
       SET TOT.KWH = 0
```

Appendix B: Thermal Consumption Accuracy

The accuracy of thermal consumption depends on the temperature sensor accuracy, the flow meter accuracy, and the temperature difference as shown in the following tables. Each table represents the thermal consumption calculation accuracy based on a specific temperature difference and combinations of temperature sensor accuracy and flow meter accuracy. For example, if a chilled water system has a temperature difference between the supply and return at 8°F and we would like to control the thermal consumption accuracy to be below 10%, we can select several combinations of temperature sensors and flow meters from the accuracy shown in Table B.2. We can choose a temperature sensor at either 0.2 or 0.5°F accuracy with a flow meter of 0.5, 1 or 2% accuracy. For instance, a combination of temperature sensors with 0.5 °F accuracy, a flow meter with 2% accuracy and an 8°F temperature difference, yield a thermal consumption calculation accuracy of 8.38%. A better accuracy can be achieved with a more accurate temperature sensor, a more accurate flow meter or a higher difference in temperature. The thermal consumption accuracy of the above example can be improved from 8.38% to 4.55% using a temperature sensor with 0.2°F accuracy. Note that the above accuracy does not include the accuracy from the controller reading, signal loss along the wire, etc. The accuracy takes into account the temperature sensor and flow meter only.

Table B.1 Thermal Consumption Calculation Accuracy Based on 5°F Temperature Difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	4.52 %	10.55 %	20.60 %	40.70 %
1	5.04 %	11.10 %	21.20 %	41.40 %
2	6.08 %	12.20 %	22.40 %	42.80 %

Table B.2 Thermal Consumption Calculation Accuracy Based on 8 °F Temperature Difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	3.01 %	6.78 %	13.06 %	25.63 %
1	3.53 %	7.31 %	13.63 %	26.25 %
2	4.55 %	8.38 %	14.75 %	27.5 %

Table B.3 Thermal Consumption Calculation Accuracy Based on 10 °F Temperature Difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	2.51 %	5.53 %	10.55 %	20.60 %
1	3.02 %	6.05 %	11.10 %	21.20 %
2	4.04 %	7.10 %	12.20 %	22.40 %

Table B.4 Thermal Consumption Calculation Accuracy Based on 12 °F Temperature Difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	2.18 %	4.69 %	8.88 %	17.25 %
1	2.68 %	5.21 %	9.42 %	17.83 %
2	3.70 %	6.25 %	10.50 %	19.00 %

Appendix C: Thermal Consumption Calculation Program

Supply and return water temperature and their flow rates are obtained for thermal consumption calculation. The following formula is used to determine a thermal energy usage, applicable to both chilled water and hot water system.

Scan.time.cur is the length in seconds of the last interpreter scan to the CURrent SCAN.
Bldg1.temp.chws is the measured CHilled Water Supply TEMPerature in °F.
Bldg1.temp.chwr is the measured CHilled Water Return TEMPerature in °F.
Temp.ret.cur is the CURrent chilled water RETurn TEMPerature in °F.
Temp.sup.cur is the CURrent chilled water SUPply TEMPerature in °F.
Bldg1.flow.chw is the measured CHilled Water FLOW rate in gpm.
Flow.cur is the CURrent chilled water FLOW rate in gpm.
Temp.diff is the calculated chilled water DIFFerential TEMPerature.
Temp.degc is the calculated chilled water return TEMPerature in °C.
Temp.P2 is chilled water return TEMPerature in °C Power of 2.
Temp.P3 is chilled water return TEMPerature in °C Power of 3.
Temp.P4 is chilled water return TEMPerature in °C Power of 4.
Temp.P5 is chilled water return TEMPerature in °C Power of 5.
Chw.density is the calculated CHilled Water DENSITY.
Mmbtuh.cur is the CURrent calculated instantaneous chilled water consumption in MMBTU/hr.
Mmbtuh.prev is the PREVious calculated instantaneous chilled water consumption in MMBTU/hr
Tot.mmbtu is the calculated TOTal chilled water consumption in MMBTU.
Scan.time.prev is the length in seconds of the last interpreter scan and the PREVious SCAN.
Monthly.mmbtu is the calculated thermal consumption in MMBTU at the end of each MONTH.
Flag2 is the local variable to determine the new month.

```
NUMERIC MONTHLY.MMBTU, TOT.MMBTU, SCAN.TIME.CUR, MMBTUH.CUR, SCAN.TIME.PREV, MMBTUH.PREV, FLAG2
NUMBERIC TEMP.SUP.CUR, TEMP.RET.CUR, FLOW.CUR, TEMP.DIFF, TEMP.DEGC, TEMP.P2, TEMP.P3, TEMP.P4, TEMP.P5, CHW.DENSITY
SET TOT.MMBTU, MMBTUH.PREV, FLAG2 = 0
LINE MMBTUCALCANDACCUM
	SCAN.TIME.CUR = SCAN
	TEMP.SUP.CUR = BLDG1.TEMP.CHWS
	TEMP.RET.CUR = BLDG1.TEMP.CHWR
	FLOW.CUR = BLDG1.FLOW.CHW
	TEMP.DIFF = TEMP.RET.CUR - TEMP.SUP.CUR
	TEMP.DEGC = (TEMP.RET.CUR - 32)*5/9
	TEMP.P2 = TEMP.DEGC * TEMP.DEGC
	TEMP.P3 = TEMP.P2 * TEMP.DEGC
	TEMP.P4 = TEMP.P3 * TEMP.DEGC
	TEMP.P5 = TEMP.P4 * TEMP.DEGC
	CHW.DENSITY = (999.8395 + 0.06798*TEMP.DEGC - 0.00911*TEMP.P2 + 0.0001*TEMP.P3 - 1.127E-06*TEMP.P4 +
		6.592E-09*TEMP.P5)/16.01846
	MMBTUH.CUR = FLOW.CUR * TEMP.DIFF * CHW.DENSITY * 1.0005 * 60 / 7.4805 / 1000 / 1000
	TOT.MMBTU = TOT.MMBTU + (MMBTUH.PREV+MMBTUH.CUR)*SCAN.TIME.CUR/7200
	MMBTUH.PREV = MMBTUH.CUR
	SCAN.TIME.PREV = SCAN.TIME.CUR
	IF (DAYOFMONTH = 28, 30 OR 31) AND TOD = 2359 THEN
		IF MONTH = 2 AND FLAG2 = 0 THEN GOTO THERMALRESET
		IF DAYOFMONTH = 30 AND TOD = 2359 THEN
			IF (MONTH = 4, 6, 9 OR 11) AND FLAG2 = 0 THEN GOTO THERMALRESET
		ELSE
			IF DAYOFMONTH = 31 AND TOD = 2359 THEN
				IF (MONTH = 1, 3, 5, 7, 8, 10 OR 12) AND FLAG2 = 0 THEN GOTO THERMALRESET
			ENDIF
		ENDIF
	ENDIF
	IF (DAYOFMONTH = 1) AND FLAG2 = 1 THEN
	SET FLAG2 = 0
	ENDIF
	GOTO MMBTUCALCANDACCUM

LINE THERMALRESET
	MONTHLY.MMBTU = TOT.MMBTU
	SET FLAG2 = 1
	SET TOT.MMBTU = 0
```

Appendix D: Extended Log Archiving Program

To retrieve all extended log entries for a point called TEMP1 on a controller called FLOOR1 and place them in a data file called Temp1Data, the following program can be used. The resulting data file would contain the time and value of each log entry.

```
Numeric OpenResult, GetLogResult, CloseResult
Numeric LogEntryValue
DateTime LogTime
Object TempPoint

OpeningLog
      OpenResult = OpenList("ExtendedLog", TempPoint, Floor1 Temp1)

Initializing
      If OpenResult is Success Then
            LogTime = Date - 30*24*3600
      Else
            Print "Could not open extended log"
      Endif

RetrievingEntry
      GetLogResult = GetExtLog(TempPoint, LogEntryValue, LogTime, Date)

TestingRetrieval
      If GetLogResult = Success Then
            Print LogTime, LogEntryValue to Temp1Data
            Goto RetrievingEntry
      Endif

ClosingLog
      CloseResult = CloseList(TempPoint)

TestingClose
      If CloseResult is not success Then
            Print "Could not close extended log"
      Endif
```

California Energy Commission
Public Interest Energy Research Program

HPCBS #
E5P2.2T2a2

HPCBS

High Performance Commercial Building Systems

Data Logging Guide for Siemens Energy Management and Control Systems

Element 5 - Integrated Commissioning and Diagnostics
Project 2.2 - Monitoring and Commissioning of Existing Buildings
Task 2.3.1 - Develop a guide to implementation of monitoring systems in existing buildings

Charles Culp
Energy Systems Laboratory, Texas A&M University
January 2003

pier
PUBLIC INTEREST ENERGY RESEARCH
"Research Powers the Future"

BERKELEY LAB

United States Department of Energy
Science, Security and Energy: Powering the 21st Century

DISCLAIMER

California Energy Commission

Data Logging Guide

for

Siemens – EMCS

Energy Management and Control Systems

Submitted by

Energy Systems Laboratory

Texas A&M University

Acknowledgments

This work was completed under contract to Lawrence Berkeley National Laboratory as part of the High Performance Commercial Building Systems program. This program is supported by the California Energy Commission's Public Interest Energy Research (PIER) Buildings Program and the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technology, Building Technologies Program, of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

Numerous individuals contributed to completing the Guide. Siemens assigned key engineers to this effort. Yasuko Sakurai from the Energy Systems Laboratory was the lead engineer on this effort. She spent several months researching engineering details to make this usable. Lindsey Turns and Lindsay Patton also spent considerable time in reviewing and editing this work. The project lead was Charles Culp, P.E., Ph.D., Associate Director of the Energy Systems Laboratory and Visiting Professor at Texas A&M University.

Siemens did not perform a final review on this document and has declined to endorse the information contained in this Guide. Siemens stated that they plan to use a wider range of equipment to accomplish these monitoring functions. The objective of this Guide was to focus on the manufacturer's existing EMCS hardware and software, since this would be definitely supported by the manufacturer. Additional monitoring devices can be added to EMCS systems, and users are urged to contract their Siemens representatives for equipment, which is directly supported by Siemens to upgrade their systems to perform data logging capabilities. Nonetheless, the authors wish to thank Siemens for the time their engineers did spend in assisting with the compiling of the data. We believe that the information contained in this Guide is correct and will be of benefit to users who want to upgrade their systems using Siemens equipment.

Table of Contents

EXECUTIVE SUMMARY

This Guide presents detailed procedures to determine the monitoring capability of an existing EMCS (Energy Management Control System) and perform any upgrades to the EMCS to enable data logging. This Guide outlines procedures to enable an existing EMCS to measure the hourly energy consumption of a building or facility. The parameters to monitor include electrical consumption, thermal consumption (flow and temperatures), room temperature and other physical parameters.

This Guide enables the user to understand and verify how the existing controller can be configured to monitor the above parameters. Briefly, this includes:

- Determining the functionality of the existing EMCS controller models and software versions.
- Upgrading the physical monitoring capability of the existing controller, if needed.
- Selecting the correct sensors for the application in existing EMCS controllers.
- Following procedures to set-up and configure the EMCS to log the desired data.

Once these procedures are fully implemented, the existing EMCS can be effectively used as a data logger. This results in a very cost effective method to acquire data logger quality data in an existing EMCS.

CHAPTER 1. INTRODUCTION

This Guide covers products designed by Siemens and introduced since 1994. A complete list of Siemens' software and hardware products that have been installed since 1994 are detailed in this Guide. Improvements to the products are also covered. This Guide presents detailed procedures to determine the monitoring capability of an existing Siemens EMCS (Energy Management Control System) and perform any needed upgrades to the EMCS to enable data logging.

Chapter 2 covers how to determine the functionality of the existing EMCS controller and software versions. Also covered is how to determine if upgrades are needed to the existing system. After implementing the steps in Chapter 2, the base system will be ready to be configured and used as a data logger.

Chapter 3 then covers specifically how to set-up and configure the EMCS as a data logger. Procedures are provided to enable selected data logger monitoring functions. These include electrical consumption, thermal flow and room monitoring. Data collection and storage requirements are also provided.

The Appendices covers programming details and accuracy determinations. A specific electrical consumption accumulation program, a thermal consumption calculation program and an extended log archiving program are provided. An example of temperature accuracy is provided so that the user can better determine the accuracy of thermal measurements.

This Guide enables the user to understand and verify that the existing controller can be configured to monitor the above parameters. Briefly, this includes:

- Determining the existing EMCS controller models and software versions.
    - Table 1 in Chapter 2 lists Siemens' controllers and software versions. If the existing controller models and software versions found in the facility are listed in Table 1, this Guide can be used to upgrade the EMCS to store historical data of the parameters needed to determine the hourly energy consumption in a facility.

- Upgrading the physical monitoring capability of the existing controller, if needed.
    - Chapter 2 contains guidance on what will need to be upgraded based on the existing EMCS models and software.
- Selecting the correct sensors for the application in existing EMCS controllers.
    - Chapter 3 provides information about what input types different controllers can accept and provides accuracy of the sensors. Guidance in selecting the correct sensor type is provided.
- Following procedures to set-up and configure the EMCS to log the desired data.
    - Chapter 3 provides procedures to configure the EMCS to log data for specific applications. The applications include electrical consumption and demand monitoring using a Watt-Hour transducer, electrical consumption and demand monitoring using a Watt transducer, thermal monitoring using a BTU meter or EMCS, monitoring room temperature and data collection and storage guidance.

CHAPTER 2. DETERMINE EXISTING SYSTEM FUNCTIONALITY

Step 1: Check the software version and the existing controller model of the controller connected to the sensor that will be used.

Step 2: Verify the firmware release and hardware/software compatibility.

Step 3: Find the general specification of the controller and the input type for each controller.

Step 4: Check data logging performance of controller.

Step 5: Upgrade EMCS for data logging

Details of each step follow.

Step 1: Check the software version and the existing controller model of the controller connected to the sensor that will be used

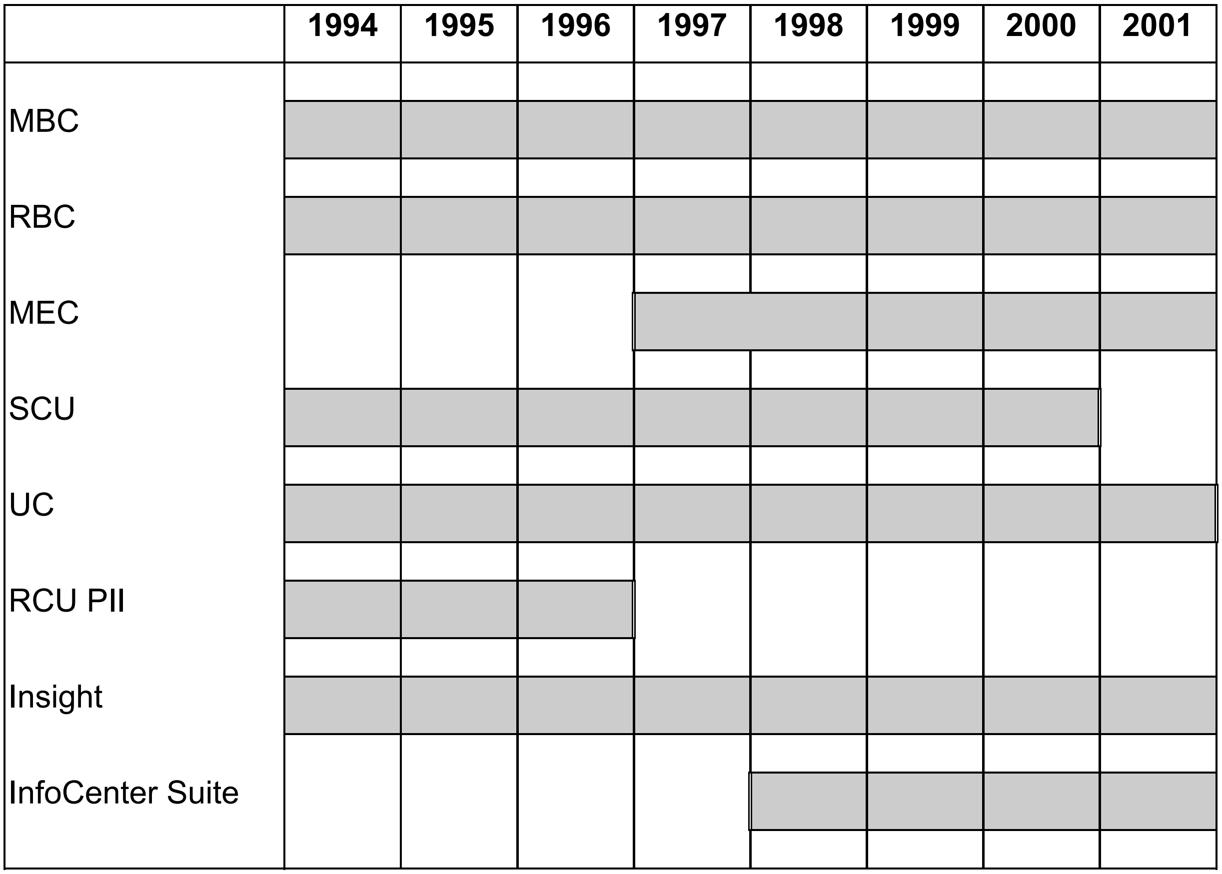
If the controller model is listed in Table 1, this manual can provide a guideline to set-up and store the history data. If the existing controller model is not included, consult with Siemens for the possibility of using the existing controller or upgrading it to a current model.

Table 1. Siemens Products of Interest

Hardware
MBC (Modular Building Controller) RBC (Remote Building Controller) MEC (Modular Equipment Controller) SCU (Stand-alone Control Unit) UC (Unitary Controller) RCU PII (Remote Control Unit)
Software
Insight InfoCenter Suite

Table 2 provides a time frame of each product listed in Table 1. The first six rows of the time row are hardware time frames and the latter two rows are the software time frame. In each row, the double lines at the beginning and the end of the year represent the starting time and the ending time of the product.

Table 2. Siemens Product History



Represents Insight and its compatible system

Represents the starting year of system which is compatible to Insight Software

Represents the ending year of system which is compatible to Insight Software

Details of controller listed in Table 1 are:

- Modular Building Controller (MBC): This controller is a modular, programmable primary controller with 24 I/O or 40 I/O module capacity enclosure and supervisory interface capability to monitor a secondary controller network. It is designed to control general HVAC applications, data acquisition and other multi-equipment applications.

- Remote Building Controller (RBC): This controller provides the same functional capabilities as the MBC with I/O count and more communications and security options to allow for remote communications. It is available in 12 module capacity enclosure.
- Modular Equipment Controller (MEC): The MEC is a modular, programmable primary control unit that does not support a secondary network. It provides 32 fixed on-board I/O, with some units having expansion capability.
- Standalone Control Unit (SCU): Tthe SCU is a programmable primary controller with supervisory interface capability to monitor a secondary network. It is required to upgrade the SCU to version 5.0 Controller Board to be able to run Apogee on the SCU. Consult with a Siemens Representative for more information.
- Unitary Controller (UC): The UC is a programmable, standalone controller with seven inputs and five outputs (expandable to 14 inputs and 10 outputs). The UC resides on the secondary floor level (P1) polling network. It is designed to perform control, monitoring and energy management functions for general HVAC applications.
- RCU PII: This unit must be upgraded by using existing wiring and installing a MBC Backplane in its place. Consult with a Siemens Representative for more information.

System 600 has two versions of revision with Insight Software, Pre-Apogee and Apogee firmware. Insight is a software program created by Siemens Building Technologies. It controls and monitors HVAC, lighting and other environmental systems. This software also allows the operator to collect operating or environmental data, generate reports, and includes a graphic package that provides an animated color display. For monitoring purposes, Insight accompanied by InfoCenter Suite, provides a means of collecting data from controllers and managing, retrieving and archiving historical data from the Insight. The procedure to set-up data collection and storage will be shown later in this manual (see Chapter 3, Application F). Insight can be run on different O/S depending on the Insight revision. Insight 1.X runs on Windows 3.12. Insight 2.X runs on Windows 95/98 and communicates with field panels that have firmware revision 1.X and 12.X. Insight 3.X runs on Windows NT and Windows 2000 and communicates with field panels that use firmware revision 2.1 and later (Apogee firmware) as well as field panels with pre-Apogee firmware. Most features, especially data collection, still work the same way. For more information, contact a Siemens representative.

Step 2: Verify the firmware release and hardware/software compatibility

The current software, Insight 3.X, is compatible with field panels that use firmware revision 2.1 and later (called Apogee firmware) and field panels with revision 1.X and 12.X (called Pre-Apogee firmware). Since Pre-Apogee firmware is not Y2K compliant, upgrading the firmware revision to Apogee firmware is recommended. Contact a Siemens representative for more information.

The field panel firmware revision can be found by running “Panel Configuration Report” on Insight software. In Insight, perform the following steps:

a. Select “Report Builder”, and then within “Definition” select “New”.
b. From the report list, select “Panel Configuration Report” and the Panel Configuration editor will be displayed.
c. Under Field Panel section, click “Add” and the object selector will be displayed.
d. Select the field panel of interest from the list and then click “OK”.
e. In Panel Configuration editor under Output click “Configure” select “Screen” and then click “OK”
f. Click the “Run Report” button and the report window will display details of the panel.

Hardware and firmware revisions can be found in this report.

Step 3: Use Table 3 to find the general specification of the controller and the input type for each controller

The four input types included for analog inputs are current, voltage, thermistor and platinum RTD. The digital input type requires the input to have a counter or accumulative feature. For example, if MBC is going to be used for the purpose of monitoring room temperature, from Table 3 shows that either current, voltage, thermistor or platinum RTD type temperature sensors can be used with this controller with the appropriate type of PTM (Point Termination Module). The appropriate sensor to use depends on the purpose of the monitoring, the required accuracy of the application and the cost of the temperature sensor. Table 3 includes the accuracy at the panel of each input type. The end-to-end accuracy can be calculated from the accuracy of the temperature sensor and the accuracy of panel reading. This will help select the correct sensor.

Table 3. Siemens Hardware Specification

Model	Analog Input				Digital Input	
	Current	Voltage	Thermistor	Platinum RTD	Digital	Counter
MBC, RBC PTM6.2P1K	N/A	N/A	N/A	1000 Ω Accuracy: N/A*	N/A	
PTM6.2N100K	N/A	N/A	100 K Accuracy: N/A*	N/A	N/A	
PTM6.2I420	4-20 mA Accuracy: N/A*	N/A	N/A	N/A	N/A	
PTM6.2U10	N/A	0-10 VDC Accuracy: N/A*	N/A	N/A	N/A	
PTM6.2C	N/A	N/A	N/A	N/A	N/A	Dry contact Freq.: 25 Hz (max) Pulse Width: 20ms (min)

* There is no general information about accuracy provided from Siemens. Contact a Siemens representative with specific sensor type for case-by-case information.

Table 3.(cont.) Siemens Hardware Specification (continued)

	Analog Input				Digital Input	
	Current	**Voltage**	**Thermistor**	**Platinum RTD**	**Digital**	**Counter**
MEC	4-20 mA Accuracy: N/A*	0-10 VDC Accuracy: N/A*	N/A	1000 W/Ω Accuracy: N/A*	Dry Contact / 250 VAC max Freq.: 25 Hz (max) Pulse Width: 20 ms (min)	
SCU	4-20 mA Accuracy: N/A*	0-10 VDC Accuracy: N/A*	100 K Accuracy: N/A*	N/A	Dry Contact / 250 VAC max Freq.: 25 Hz (max) Pulse Width: 20 ms (min)	
UC	0-20 mA Accuracy: 0.5% [0.05% typical]	0-10 VDC Accuracy: 0.5% [0.09% typical]	N/A	-40 to 350°F Accuracy: 1.8°F [0.5°F typical]	Dry Contact Freq.: 10 Hz (max) Pulse Width: N/A** ms (min)	

* There is no general information about accuracy provided from Siemen. Contact a Siemens representative with specific sensor type for case-by-case information.

** The minimum pulse width is not provided but speculated to be at least 50 ms. Contact a Siemens representative for more details.

Step 4: Check data logging performance of controller

Knowing the existing controller, use Table 4 to check the acceptable data logging performance of the controller for each monitoring parameter: electrical consumption, thermal consumption and room temperature. Table 4 provides recommendations in the event the existing controller cannot be used to monitor a parameter.

Table 4. Siemens Hardware and Monitoring Capabilities Compatibility

	Electrical Consumption		**Thermal Consumption**		**Room Temperature**
Sensor Device Output	Digital	Analog	Digital	Analog	Analog
MBC	•	•	•	•	•
RBC	•	•	•	•	•
MEC	•	•	•	•	•
SCU	X[1]	X[1]	X[1]	X[1]	X[1]
UC	•	•	•	X[2]	•
RCU PII	X[3]	X[3]	X[3]	X[3]	X[3]

• Indicates acceptable performance for logging a point type

X[1] SCU must be upgraded to SCU Version 5 Controller

X[2] UC can be used for thermal consumption calculation with current or voltage input type only

X[3] RCU PII must be upgraded by using existing wiring and installing a MBC backplane.

Step 5: Upgrade EMCS for data logging

The suitability of the existing EMCS equipment should now be determined so that any needed upgrades can be accomplished. For example, if a remote panel needs to be upgraded to improve the accuracy, this should be done before continuing with the set-up procedures in Chapter 3.

After establishing the compatibility and type of parameter to be monitored and logged and after knowing which type of meter or calculation to be used, the set-up procedures can be selected.

The following application set-up procedures are outlined in Chapter 3 for specific functions:

- Electrical Consumption and Demand Monitoring Using Watt Hour Transducer (digital input)
- Electrical Consumption and Demand Monitoring Using Watt Transducer (analog input)
- Thermal Consumption Monitoring Using BTU Meter
- Thermal Consumption Monitoring Using EMCS
- Room Temperature Monitoring

CHAPTER 3. APPLICATION SET-UP PROCEDURES

The following procedures and charts provide the requirements to enable the existing controllers to perform the specified functions. These procedures are covered in detail in Chapter 3.

Application A. Electrical Consumption and Demand Monitoring Using A Watt-Hour Transducer.
Application B. Electrical Consumption Monitoring Using A Watt Transducer.
Application C. Thermal Consumption Monitoring Using a BTU Meter.
Application D. Thermal Consumption Monitoring Using an EMCS.
Application E. Room Temperature Monitoring.
Application F. Data Collection Configuration and Storage in Insight and Data Collection and Archiving in Infocenter.

Application A. Electrical Consumption and Demand Monitoring Using a Watt Hour Transducer

Application A provides the user with steps to follow in setting up a Watt Hour Transducer to monitor electrical consumption and demand. By following these steps, the user will enable the EMCS to measure electrical consumption (kWh) and store fifteen-minute data. Chart A-1 lists the needed equipment and helps the user determine if the controller has an available input slot. Chart A-2 aids the user in choosing a Watt Hour Transducer (WHT) and a Current Transducer (CT). The chart lists the accuracy, pulse widths, and pulse rates for each controller model that the WHT must have. The chart also lists wire and sensor specifications. Tips for CT installation are provided as well. Chart A-3 provides an example of a WHT and a CT available in the market. Chart A-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate daily and monthly consumption and record 15-minute consumption. The user should proceed to Application F to set-up the data collection and history data storage.

Step 1. Check the input slot availability on the controller.

Use Chart A-1 to find which slots are needed on the controller. The position of the slot can be found in Chart A-1 under Controller Terminal Connections. For example, the MBC has two enclosure sizes, 24 module size and 40 module size. If there is a slot available, PTM6.2C will be installed. If there are no available slots, contact a Siemens representative to determine whether an expansion I/O module can be added to this controller or if an additional controller should be installed.

Step 2. Choose a Watt-Hour Transducer (WHT) and Current Transducer (CT).

Chart A-2 lists the WHT and CT specifications. For example, an acceptable Watt-Hour Transducer for the RBC should have digital output with ± 0.5% accuracy or better and at least 20 ms pulse width at 25 Hz maximum pulse rate. With matching CT output and accuracy selection of ± 1% or better, the end-to-end accuracy from the transducers to the

RBC controller could estimate ± 1.5%. Note that to gain this accuracy the transducers must be placed no more than 750 ft. away with 14-22 AWG type wire.

Chart A-3 shows an example of a WHT and a CT provided in the market.

Step 3. Follow the EMCS programming steps.

Chart A-4 provides the steps to set-up the EMCS to accumulate daily consumption, accumulate monthly consumption, and update the values every fifteen minutes. Detailed steps provided in this chart must be followed to set-up the external pulse input points and internal analog output points.

Step 4. Follow the steps in Application F.

Application F lists the steps to set-up the data collection and history data storage.

After following these steps, the system can collect daily and monthly consumption as well as record 15-minute data.

Chart A-1. Electrical Consumption and Demand Monitoring Using a Watt Hour Transducer

Verify that in addition to the sensors and transducer, that the controller has the available slots as discussed below.

	MBC	RBC	MEC	SCU	UC
What is measured	• Electrical consumption data of either One-Phase or Three Phase, 208 to 480 V ac rms., 2400 amps (max), 50/60 Hz				
What is stored in EMCS	• Fifteen-minute data of electrical consumption in kWh units stored in Trend Data History.				
What is needed	3 - CT sensor 1 - Watt Hour Transducer 1 - available slot on Terminal Block (for external discrete input) 1 - available internal analog output point (to accumulate month-to-date consumption)				
Terminal Connections	PTM6.2C	PTM6.2C	DI 5 – DI 8	TB1 DI-24 to DI-29	I/O card1: DI10–DI12 I/O card2: DI30–DI32

Chart A-2. Electrical Consumption and Demand Monitoring Using a Watt Hour Transducer

Watt Hour Transducer and Current Transducer Specifications

	MBC	RBC	MEC	SCU	UC
Output Type from Watt Hour Transducer	Digital (each pulse is equal to xxx kWh, varies with specific sensor)				
Maximum Pulse Rate	25 Hz	25 Hz	25 Hz	25 Hz	10 Hz
Minimum Pulse Width	20 ms	20 ms	20 ms	20 ms	N/A*
Accuracy from Watt Hour Transducer	± 0.5 % (not including CT's)				
Maximum Wire Length (ft.)	750 ft. @ 14-22 AWG				
CT Accuracy	± 1.0 %				
Note	CT sensors Output: Match the input type for Watt Hour Transducer Input: Make sure that input current is enough to cover the normal current				
End-to-end Accuracy	± 1.5 %				

* The minimum pulse width is not provided but speculated to be at least 50 ms. Contact a Siemens representative for more details.

Make sure that the device will cover the peak demand kW, will not generate more pulses than the maximum pulse rate and will maintain the signal pulse width at least for the minimum pulse width duration.
Notes on installation:

- Install CT sensors on the electrical main panel. Follow the manufacturer's instructions.
- Terminate the Watt-Hour Transducer output at the Terminal Block. Follow the manufacturer's instructions.
- Install the Watt Hour Transducer and terminate the CT sensor outputs at the WHT inputs. Follow the manufacturer's instructions.
- Electrical shock can occur from CT's without a shunt resistor.

Chart A-3. Electrical Consumption and Demand Monitoring Using a Watt Hour Transducer

Example of Watt Hour Transducer Specifications

The following Watt-Hour Transducer has been used successfully.

Watt Hour Transducer		
Ohio Semitronics, Inc.		
WL-3968		
Input	Current	Output from Current Transformer 0 - 0.333 V
	Voltage	120/208 & 277/480
	Phase	Three-Phase, Three-Wire or Three-Phase, Four-Wire
	Range	± 15%
	Burden	None
	Power Factor	0.5 Lead to 0.5 Lag
	Instrument Power	208/240/480, 50/60 Hz, 2.5 Watts
Output	Relay	Dry Contact, 120 V, 0.3 A, 10 VA Max
	Closure Duration	250 Milliseconds
	Accuracy	± 0.5% F.S.
	Isolation	Input/Output/Case 750 VAC
	Temperature Effects	(-20°C to +60°C) ± 0.02%/°C

Chart A-3. Electrical Consumption and Demand Monitoring Using a Watt Hour Transducer (continued)

Example of Current Transducer Specifications

The following Current Transducer has been successfully used.

Current Transducer		
Sentran Corporation		
4LS3 Split Bus Bar		
Input	Current	AC current, sine wave, single phase 60 Hz, Load PF 0.5-1 lead or lag 100, 200, 300, 400, 500, 600, 800, 1K, 1.5K, 2K, 2.5K and 3K Amp
	Voltage rating	600 V ac Tested Per ANSI C57.13 BIL 10 kV AC Full Wave for 60 seconds
	Bandwidth	10 Hz to 1000 Hz ± 3 dB
Output	Voltage	100 mV, 250 mV, 333 mV, 500 mV, 1 V and 5 V
	Limiting	20 V AC RMS
	Accuracy	± 1% ratio and linearity accuracy from 5% to 200% of scale
	Phase Displacement	± 1 degree
	Output Resistance	< 100 Ohms
	Interface Resistance	> 10K Ohms
	Lead Wires	20 or 22 AWG UL1015, 600V insulation, 105 C

Chart A-4. Electrical Consumption and Demand Monitoring Using a Watt Hour Transducer

EMCS Programming Steps

Summary

Step 1. Set-up an external pulse input (LPACI) point in EMCS to accumulate daily consumption for Wh-to-pulse transducer.

Step 2. Set-up an internal analog output (LAO) point to accumulate monthly consumption from external point created in Step 1.

Step 3. Add a programming step to update the point value created in Step 2 every 15 minutes.

Step 4. Create a trend point extension on the internal analog output point in the EMCS to record the 15-minute accumulated consumption values.

Details of these steps follow.

Step 1. Set-up an external pulse input (PI) point in EMCS to accumulate daily consumption for Wh-to-pulse transducer.

In Insight Apogee, perform the following steps:

a. Connect installed sensors to the controller

b. Select “Point Editor”, then in the Point Menu select “New”, then “LPACI (Logical Pulse Accumulator Input)”

c. The new point window editor will be displayed. Set the following parameters as specified below:

<table>
<tr><th></th><th>MBC</th><th>RBC</th><th>MEC</th><th>SCU</th><th>UC</th></tr>
<tr><td>System Name</td><td colspan="5">Enter a name up to 30 characters in length. For example, BLDG1.elec</td></tr>
<tr><td>Point Name</td><td colspan="5">Enter a name up to 30 characters in length. For example, BLDG1.kWh</td></tr>
<tr><td>Field Panel</td><td colspan="5">Click the button to show a list of field panels on the network. Select the name of the field panel that contains the point</td></tr>
<tr><td>Descriptor</td><td colspan="5">Enter up to 16 characters in length to provide some additional explanation about the application or location of the point</td></tr>
<tr><td rowspan="2">Address for current firmware revision (MBC/RBC: 2.0 or higher, SCU/UC: 12.4.2 or higher)</td><td colspan="5">L . DDD . PPPPP
L: FLN number, 0-3
D: Drop number, 0-099
P: Point number, 0-65,000</td></tr>
<tr><td colspan="2">L is equal to 0
D is the address key number in the PTM (Point Termination Module)
P is the actual hardware layout number</td><td>L is equal to 0
D is equal to 0 if point resides in MEC, or FLN number
P can be 5-8.</td><td>L is equal to 0
D is the termination board number
P is the termination point number</td><td>L is FLN connecting number on field panel
D is FLN device number
P is the termination point number</td></tr>
<tr><td>Engineering Unit</td><td colspan="5">kWh</td></tr>
<tr><td>Invert Value</td><td colspan="5">No</td></tr>
<tr><td>Count Both Edges</td><td colspan="5">No</td></tr>
<tr><td>Gain</td><td colspan="5">Value/pulse. For example, if a pulse from WHT is equal to 100 Wh, the gain is equal to 0.1 (the engineering unit is kWh)</td></tr>
<tr><td>Initial Value</td><td colspan="5">0</td></tr>
<tr><td>COV Limit</td><td colspan="5">At least equal to gain number</td></tr>
</table>

Step 2. Set-up an internal logical analog output (LAO) point to accumulate monthly consumption from the external point created in Step 1.

In Insight Apogee, perform the following steps:

a. Select “Point Editor”, then Point Menu select “New”, then “LAO (Logical Analog Output)”

b. New point window editor will be displayed. Set the following parameters as specified below:

	MBC	RBC	MEC	SCU	UC
System Name	Enter a name up to 30 characters in length. For example, BLDG1.elec				
Point Name	Enter a name up to 30 characters in length. For example, BLDG1.kWh1				
Field Panel	Click the button to show a list of field panels on the network, then select name of the field panel that contains the point				
Descriptor	Enter up to 16 characters in length to provide some additional explanation about the application or location of the point				
Address for current firmware revision (MBC/RBC: 2.0 or higher, SCU/UC: 12.4.2 or higher)	Check (P) box and (V) is displayed in the field. Insight will automatically assign an address to this virtual point.				
Engineering Unit	kWh				
COV Limit	At least equal to Gain number of the above LPACI point				
Initial Value	0				
Totalization	Hourly				
	• Leave all other items at their default value and click “OK.”				

<u>Step 3</u>. Add a programming step to update the point value created in Step 2 every 15 minutes.

In Insight Apogee, perform the following steps:

a. Select “Program Editor”, then in the Program Menu select “New”
b. New program window editor will be displayed, enter the PPCL program lines (See Appendix A). Press Enter at the end of each program line
c. From Program Menu select “Save As.”

Set the following parameters as specified below.

System Name	Enter a unique name up to 30 characters in length. For example, BLDG1.consumption
Name	Enter a unique name up to 30 characters in length. For example, BLDG1.consumption
Field Panel	Click the button to show a list of field panels on the network, then select name of the field panel that contains the point
	• Click “OK”

<u>Step 4</u>. Create a trend point extension on the internal analog output point in the EMCS to record the 15-minute accumulated consumption values.

In Insight Apogee, perform the following steps:

a. Select "Trend Definition Editor" from the Trend Menu and select "New".
b. The Object Selector appears, select the LAO point above and click "OK".
c. The Trend Type dialog box appears, select "COV" and click "OK".
d. The Add COV Definition dialog box appears.

Set the following parameters as specified below.

Panel Samples Desired	300 samples (Panel can keep data for 3 days) or the Maximum Samples available at Panel, whichever is less
Trend COV Limit	Select "Use Trend COV Limit" with 0.01 value
PC Buffer size	1000 (PC can keep data for 10 day) or the maximum Insight Storage number, whichever is less
Enable PC Collection	Check this box to enable PC for data collection
Enable "COV Buffer Full" Notification	Check this box to enable control panel to notify Insight when the trend buffer has reached 80% full
	• Click "OK" to close the Add COV Definition dialog box
	• Click "OK" to the Operation Successful message

Application B. Electrical Consumption Monitoring Using a Watt Transducer

Charts B-1 through B-4 will take the user through steps to set-up a Watt Transducer to monitor electrical consumption and demand. Following these steps will enable the EMCS to measure electrical consumption (kWh) and store fifteen-minute data. Chart B-1 lists the needed equipment and will help the user determine if the controller has an available input slot. Chart B-2 aids the user in choosing a Watt Transducer (WT) and a Current Transducer (CT). The chart lists the accuracy, output type, wire specifications, and sensor specifications for the different controller models. Tips for CT installation are also provided. Chart B-3 provides an example of a WT with a CT available in the market. Chart B-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate daily consumption, display current demand, and record 15-minute consumption. The user should proceed to Application F to set-up the data collection and history data storage.

Step 1. Check the input slot availability on the controller.

Use Chart B-1 to find which slots are needed on the controller. The position of the slot can be found in Chart B-1 under Controller Terminal Connections. For example, the RBC has 12 modules enclosure size. If there is a slot available, PTM6.2I420 will be installed. If there are no available slots, contact a Siemens representative to determine whether an expansion I/O module can be added to this controller or if an additional controller should be installed.

Step 2. Choose a Watt Transducer (WT) and Current Transducer (CT).

Chart B-2 lists the WT and CT specifications. For example, an acceptable Watt Transducer for RBC should have analog output (preferred current 4-20 mA) with 0.5% accuracy or better. With matching CT output and accuracy selection of 1% or better, the end-to-end accuracy from the transducers to the RBC controller is at least 1.5% plus the accuracy of RBC current input. Note that to gain this accuracy the transducers must be placed no more than 750 ft. away with 14-22 AWG wire type. Chart B-3 shows an example of WT provided in the market. This Watt Transducer example includes the CT.

Step 3. Follow the EMCS programming steps.

Chart B-4 provides the steps to set-up the EMCS to accumulate daily consumption, accumulate monthly consumption, and update the values every fifteen minutes. Detailed steps provided in this chart must be followed to set-up the external analog input points and internal analog output points.

Step 4. Finally, follow the steps in Application F.

Application F lists the steps to set-up the data collection and history data storage.

After completing the above steps, the EMCS system can accumulate daily consumption, display current demand, and record 15-minute consumption.

Chart B-1. Electrical Consumption Monitoring Using a Watt Transducer

Verify that in addition to the sensors and transducer, that the controller has the available slots as discussed below.

	MBC	RBC	MEC	SCU	UC
What is measured	Electrical consumption data of either One-Phase or Three Phase, 208 to 480 VACrms, 2400 amps (max), 50/60 Hz				
What is stored in EMCS	Fifteen-minute data of electrical consumption in kWh unit stored in Trend Data History.				
What is needed	3 - CT sensor 1 - Watt Transducer 1 – available slot on Terminal Block (for external analog input) 1 – available internal analog output point (to accumulate month-to-date consumption)				
Terminal Connections	PTM6.2I420	PTM6.2I420	AI 17 – AI 24	TB2-5 AI-00 to AI-15	I/O card1: UI13–UI16 I/O card2: UI33–UI36

Chart B-2. Electrical Consumption Monitoring Using a Watt Transducer

Watt Transducer and Current Transducer Specifications

	MBC	RBC	MEC	SCU	UC
Output Type from Watt Transducer	Analog, 4-20 mA				
Accuracy from Watt Transducer	± 0.5 % (not including CT's)				
Maximum Wire Length (ft.)	750 ft. @ 14-22 AWG				
CT Accuracy	± 1.0 %				
Note	CT sensors • Output: Match the input type for Watt Transducer • Input: Make sure that input current is enough to cover the normal current				
End-to-end Accuracy	± 1.5 % plus the accuracy of the analog reading of each controller. Contact Siemens representative for specific information.				

Make sure that the device will cover the peak demand kW, will not generate more pulses than the maximum pulse rate and will maintain the signal pulse width at least for the minimum pulse width duration.

Notes on installation:

- Install CT sensors on the electrical main panel, and follow the manufacturer's instructions.
- Install Watt Transducer and terminate CT sensors outputs at the WT inputs, and follow the manufacturer's instructions.
- Electrical shock can occur from CT's without a shunt resistor.
- Terminate Watt Transducer output at Terminal Block, and follow the manufacturer's instructions.

Chart B-3. Electrical Consumption Monitoring Using Watt Transducer

Example of Watt Transducer Specifications

Watt Transducer (CT included)		
Veris Industries, Inc.		
H-8040		
Input	Primary Voltage	208 or 480 V ac rms.
	Phase	One-Phase or Three-Phase
	Primary Current	Up to 2400 amps cont. per phase
Output	Type	4 – 20 mA
	Supply Power	9 – 30 V dc; 30 mA max
	Accuracy	± 1%
	Internal Isolation	2000 V ac rms.
	Case Insulation	600 V ac rms.
	Current Transformer	Split core, 100, 300, 400, 800, 1600 or 2400 amps

Chart B-4. Electrical Consumption Monitoring Using a Watt Transducer

<u>EMCS Programming Steps</u>

<u>Summary</u>

1. Set-up an external analog input (LAI) point in EMCS to store demand from the Watt transducer.
2. Set-up an internal analog output point in EMCS to accumulate monthly consumption from the Watt Transducer.
3. Add a programming step to accumulate the point value created in Step 1 and store in the point created in Step 2. This process will occur every 15 minutes.
4. Create Trend point extension on internal analog output point in EMCS to record 15-minute accumulated consumption values.

Details of these steps follow.

<u>Step 1</u>. Set-up external analog input (LAI) point in EMCS to store demand from the Watt Transducer.

In Insight Apogee, perform the following steps:

a. Connect installed sensors to the controller.
b. Select “Point Editor”, then in the Point Menu select “New”, then “LAI (Logical Analog Input).”
c. New point window editor will be displayed.

Set the following parameters as specified below:

<table>
<tr><th></th><th>MBC</th><th>RBC</th><th>MEC</th><th>SCU</th><th>UC</th></tr>
<tr><td>System Name</td><td colspan="5">Enter a name up to 30 characters in length. For example, BLDG1.elec</td></tr>
<tr><td>Point Name</td><td colspan="5">Enter a name up to 30 characters in length. For example, BLDG1.kWh1</td></tr>
<tr><td>Field Panel</td><td colspan="5">Click the button to show a list of field panels on the network, then select name of the field panel that contains the point</td></tr>
<tr><td>Descriptor</td><td colspan="5">Enter up to 16 characters in length to provide some additional explanation about the application or location of the point</td></tr>
<tr><td rowspan="2">Address for current firmware revision (MBC/RBC: 2.0 or higher, SCU/UC: 12.4.2 or higher)</td><td colspan="5">L . DDD . PPPPP
L: FLN number, 0-3
D: Drop number, 0-099
P: Point number, 0-65,000</td></tr>
<tr><td colspan="2">L is equal to 0.
D is the address key number in the PTM (Point Termination Module).
P is the actual hardware layout number.</td><td>L is equal to 0.
D is equal to 0 if point resides in MEC, or FLN number
P can be 17-24.</td><td>L is equal to 0.
D is the termination board number.
P is the termination point number.</td><td>L is FLN connecting number on field panel.
D is FLN device number.
P is the termination point number.</td></tr>
<tr><td>Engineering Unit</td><td colspan="5">kW</td></tr>
<tr><td>Slope/Intercept</td><td colspan="5">Choose Slope/Intercept button to open Slope Intercept Calculator dialog box with following parameters</td></tr>
</table>

	MBC	RBC	MEC	SCU	UC
Calculate Based On	MBC/RBC		MEC	SCU	UC
Sensor Type	Current				
Calculate Using	English				
Signal Range	Low Value: 4 High Value: 20 (in mA unit)				
Device Range	Low Value: the kW value corresponding to the low signal from sensor High Value: the kW value corresponding to the high signal from sensor For instance, Watt Transducer is set-up to send out signal 0 kW demand at 4 mA and 500 kW demand at 20 mA, the low value in this case is 0 and the high value is 500.				
	• Click “Calculate” button to calculate the slope and intercept value				
	• Click “OK” to return to point window				
COV Limit	10 times of slope value				
Sensor Type	Current				
Totalization Rate	Hourly				
	• From the Point menu, select “Save”				

Step 2. Set-up an internal analog output point in EMCS to accumulate monthly consumption from the Watt Transducer.

In Insight Apogee, perform the following steps:

a. Select “Point Editor”, then in the Point Menu select “New”, then “LAO (Logical Analog Output)”.

b. New point window editor will be displayed. Set the following parameters as specified below:

	MBC	RBC	MEC	SCU	UC
System Name	Enter a name up to 30 characters in length. For example, BLDG1.elec				
Point Name	Enter a name up to 30 characters in length. For example, BLDG1.kWh1				
Field Panel	Click the button to show a list of field panels on the network, then select name of the field panel that contains the point				
Descriptor	Enter up to 16 characters in length to provide some additional explanation about the application or location of the point				
Address for current firmware revision (MBC/RBC: 2.0 or higher, SCU/UC: 12.4.2 or higher)	Check (P) box and (V) is displayed in the field. Insight will automatically assign an address to this virtual point.				
Engineering Unit	kWh				
COV Limit	Equal to COV Limit of the above LAI point				
Initial Value	0				
Totalization	Hourly				
	Leave all other items at their default value and click “OK.”				

Step 3. Add a programming step to accumulate the point value created in Step 1 and store in the point created in Step 2.

This process will occur every 15 minutes.

In Insight Apogee, perform the following steps:

a. Select “Program Editor”, then in the Point Menu select “New”, then “LAO (Logical Analog Output)”.
b. New program window editor will be displayed, enter the PPCL program lines (See Appendix B). Press Enter at the end of each program line.
c. When finished, from Program Menu select “Save As”. The Save As dialog box displays with the following parameters.

	MBC	RBC	MEC	SCU	UC
System Name	Enter a unique name up to 30 characters in length. For example, BLDG1.consumption				
Name	Enter a unique name up to 30 characters in length. For example, BLDG1.consumption				
Field Panel	Click the button to show a list of field panels on the network, then select the name of the field panel that contains the point				
	• Click “OK”				

Step 4. Create Trend point extension on internal analog output point in EMCS to record 15-minute accumulated consumption values.

In Insight Apogee, perform the following steps:

a. Select “Trend Definition Editor”. From the Trend Menu, select “New”.
b. From the Object Selector displays, select the LAO point above and click “OK”.
c. When the Trend Type dialog box displays, select “COV” and click “OK”.
d. The Add COV Definition dialog box displays. Set the following parameters as specified below:

Panel Samples Desired	300 samples (Panel can keep data for 3 days) or the Maximum Samples available at Panel, whichever is less
Trend COV Limit	Select “Use Trend COV Limit” with 0.01 value
PC Buffer size	1000 (PC can keep data for 10 days) or the maximum Insight Storage number, whichever is less
Enable PC Collection	Check this box to enable PC for data collection
Enable “COV Buffer Full” Notification	Check this box to enable control panel to notify Insight when the trend buffer has reached 80% full
	Click “OK” to close the Add COV Definition dialog box
	Click “OK” to the Operation Successful message

Application C. Thermal Consumption Monitoring Using a BTU Meter

Charts C-1 through C-4 will take the user through steps to set-up a BTU meter to monitor thermal consumption. Following these steps will enable the EMCS to measure thermal consumption (MMBtu) and store fifteen-minute data. Chart C-1 lists the needed equipment and will help the user determine if the controller has an available input slot. Chart C-2 aids the user in choosing a BTU meter, temperature sensors, and a flow meter. The chart lists the output type, pulse widths, and pulse rates for the different controller models that the BTU meter must have. The table also provides recommended temperature sensor and flow meter accuracy. Tips for BTU meter selection and flow meter installation are provided at the end. Chart C-3 provides an example of a BTU meter, a temperature sensor, and a flow meter available in the market. Chart C-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to collect daily and monthly consumption. The user should proceed to Application F to set-up the data collection and history data storage.

Step 1. Check the input slot availability on the controller.

Use Chart C-1 to find which slots are needed on the controller. The position of the slot can be found in Chart C-1 under Terminal Connections. For example, the MEC has an input / output point board, which supports eight digital inputs. In this board, the eight inputs-only terminal connection, DI5 – DI8, are pulse accumulator inputs. If there is a slot available, the procedure can be followed. If there are no slots available, contact a Siemens representative to determine whether an expansion I/O module can be added to this controller or if an additional controller should be installed.

Step 2. Choose a BTU meter, temperature sensor and flow meter.

Chart C-2 lists the BTU meter, temperature sensor and flow meter specifications. For example, an acceptable BTU meter for MEC should have digital output with at least 20 ms pulse width at 25 Hz maximum pulse rate. This BTU meter should be installed with matching temperature sensors and flow meter output at the recommended accuracy. The end-to-end accuracy of this thermal measurement depends on the meter and sensors as well as the characteristics of the system (differential temperature). Chart C-2 and Appendix B provide more information regarding this. Chart C-3 shows examples of a BTU meter, temperature sensors and a flow meter provided in the market.

Step 3. Follow the EMCS programming steps.

Chart C-4 provides the steps to set-up the EMCS to collect daily and monthly consumption, update the data every fifteen minutes, and record the consumption values. Detailed steps provided in this chart must be followed to accomplish these tasks.

Step 4. Finally, follow the steps in Application F.

Application F lists the steps to set-up the data collection and history data storage.

After following the above steps, the EMCS system can collect daily and monthly consumption.

Chart C-1. Thermal Consumption Monitoring Using a BTU Meter

Verify that in addition to the sensors and transducer, that the controller has the available slots as discussed below.

	MBC	RBC	MEC	SCU	UC
What is measured	• Chilled/Hot water flow • Chilled/Hot water supply and return temperature				
What is stored in EMCS	• Fifteen-minute data of Thermal Consumption in MMBtu units stored in Trend Data History				
What is needed	1 – Flow meter 2 – Temperature sensors 1 – BTU meter 1 – available slot on Terminal Block (for digital input) 1 – available internal analog output point (to accumulate month-to-date consumption)				
Terminal Connections	PTM6.2C	PTM6.2C	DI 5 – DI 8	TB1 DI-24 to DI-29	I/O card1: DI10–DI12 I/O card2: DI30–DI32

Chart C-2. Thermal Consumption Monitoring Using a BTU Meter

Btu Meter, Flow Meter and Temperature Sensor Specifications

	MBC	RBC	MEC	SCU	UC
Output Type from BTU Meter	Digital (each pulse is equal to xxx MMBtu, varies with specific sensor)				
Maximum Pulse Rate	25 Hz	25 Hz	25 Hz	25 Hz	10 Hz
Minimum Pulse Width	20 ms	20 ms	20 ms	20 ms	N/A*
Maximum Wire Length (ft.)	750 ft. @ 14-22 AWG				
Flow meter accuracy	Recommended accuracy for the flow meter is ±1% full scale				
Temperature sensor accuracy	• Recommended accuracy for chilled water temperature sensors is ± 0.2 °F • Recommended accuracy for hot water temperature sensor is ± 0.5 °F				
End-to-end accuracy	The end-to-end accuracy depends on the accuracy of the temperature sensors, flow meter and how large the temperature difference is. Assuming a difference between chilled water supply and return temperature of 10 °F, the end-to-end accuracy can approach 5%. Assuming a difference between hot water supply and return temperature of 20 °F, the accuracy can approach 7%, without end-to-end calibration. See Appendix B				

* The minimum pulse width is not provided but speculated to be at least 50 ms. Contact a Siemens representative for more details.

Tips on BTU Meter selection:

- Ensure that the BTU meter will cover the peak BTU, will not generate pulses more than the maximum pulse rate and will maintain the output pulse signal with at least the minimum pulse width duration.
- Use matched temperature sensors.
- Temperature sensor and flow meter outputs are correct for the BTU meter inputs.

Notes on installation:

- Install a flow meter on the supply pipe or return pipe.
- Install matched temperature sensors, one on the supply pipe and another on the return pipe.
- For the temperature sensor on the same pipe as the flow meter, install the sensor close to the flow meter.
- Disconnect the flow meter and temperature sensors at the BTU meter input board. Follow the manufacturer’s instructions.
- Disconnect the BTU meter at the terminal block. Follow the manufacturer’s instructions.

Chart C-3. Thermal Consumption Monitoring Using a BTU Meter

An Example of a BTU Meter, Flow Meter and Temperature Sensor Specifications

The following BTU meter, flow meter and temperature sensors have been used successfully.

Btu Measurement System		
Keegan Electronics, Inc.		
System 90 Series		
Input	Temperature	2 match temperature sensors supplied by Keegan Electronics
	Minimum Resolution of Temperature reading	0.1°C
	Flow	1 flow sensor supplied by Data Industrial
	Minimum Closure Duration	2 milliseconds
	Maximum Length of cable	500 feet
	Electrical	Connect to high voltage (120 V AC) through a circuit breaker
Output	Standard Output	Monostable relay outputs, SPST, 2A @ 120 V AC resistive representing BTU's and Gallons
	Optional Output	0-1 mA DC or 4-20 mA DC representing instantaneous BTU/HR and GPM
	Accuracy	Depends on the accuracy of temperature sensor, flow meter and how large the temperature difference is.

Temperature Sensor		
Keegan Electronics, Inc.		
RTD for System 90 Series		
Input	Temperature Range	0-100 °C
Output	Standard Output	RTD – variable resistance
	Reference	@ 0°C – output is equal to 32,654 ohms @ 100°C – output is equal to 679 ohms
	Accuracy	± 0.2 °C

Chart C-3. Thermal Consumption Monitoring Using a BTU Meter (continued)

Example of BTU Meter, Flow Meter and Temperature Sensor Specifications

Flow Sensor		
Data Industrial		
220 PVCS Insert Flow Sensor		
Input	Flow Rate	1 to 30 ft./sec
	Maximum Pressure	100 psi @ 68°F
	Maximum Temperature	140°F @ 40 psi
	Maximum Length of cable	20 feet shielded twisted pair AWG 20
Output	Standard Output	Voltage pulse, 5V or greater
	Accuracy	± 1% of Full Scale (over recommended design flow range)
	Absolute Accuracy	± 4% of reading within calibration range
	Linearity	± 1%
	Frequency	3.2 – 200 Hz
	Pulse Width	5 milliseconds ± 25%

Chart C-4. Thermal Consumption Monitoring Using a BTU Meter

EMCS Programming Steps

Summary

1. Set-up an external pulse input (LPACI) point in EMCS to accumulate daily consumption for the BTU meter.
2. Set-up an internal analog output (LAO) point to accumulate monthly consumption from the external point created in Step 1.
3. Add a programming step to update the accumulated monthly consumption value every 15 minutes.
4. Create Trend point extension on the internal analog output point in the EMCS to record 15-minute accumulated consumption values.

Details of these Steps follow.

Step 1. Set-up external pulse input (LPACI) point in EMCS to accumulate daily consumption for the BTU meter.

In Insight Apogee, perform the following steps:

a. Connect installed sensors to the controller.

b. Select “Point Editor”. Then in the Point Menu select “New”, then “LPACI (Logical Pulse Accumulator Input)”.

c. The new point window editor will be displayed. Set the following parameters as specified below.

	MBC	RBC	MEC	SCU	UC
System Name	Enter a name up to 30 characters in length. For example, BLDG1.therm				
Point Name	Enter a name up to 30 characters in length. For example, BLDG1.chwmmbtu				
Field Panel	Click the button to show a list of field panels on the network, then select name of the field panel that contains the point				
Descriptor	Enter up to 16 characters in length to provide some additional explanation about the application or location of the point				
Address for current firmware revision (MBC/RBC: 2.0 or higher, SCU/UC: 12.4.2 or higher)	L . DDD . PPPPP L: FLN number, 0-3 D: Drop number, 0-099 P: Point number, 0-65,000				
	L is equal to 0. D is the address key number in the PTM (Point Termination Module). P is the actual hardware layout number.		L is equal to 0. D is equal to 0 if point resides in MEC, or FLN number P can be 5-8.	L is equal to 0. D is the termination board number. P is the termination point number.	L is FLN connecting number on field panel D is FLN device number. P is the termination point number.
Engineering Unit	MMBtu				
Invert Value	No				
Count Both Edges	No				
Gain	Value/pulse. For example, if a pulse from BTU meter is equal to 0.01 MMBtu, Gain is equal to 0.01				
Initial Value	0				
COV Limit	At least equal to Gain number				

Step 2. Set-up internal analog output point in EMCS to accumulate monthly consumption from the BTU meter.

In Apogee Insight, perform the following steps:

a. Select “Point Editor”. Then in the Point Menu select “New”, then “LAO (Logical Analog Output)”.

b. The new point window editor will be displayed. Set the following parameters as specified below:

System Name	Enter a name up to 30 characters in length. For example, BLDG1.therm
Point Name	Enter a name up to 30 characters in length. For example, BLDG1.chwmmbtu1
Field Panel	Click the button to show a list of field panels on the network. Then select name of the field panel that contains the point
Descriptor	Enter up to 16 characters in length to provide some additional explanation about the application or location of the point
Address for current firmware revision (MBC/RBC: 2.0 or higher, SCU/UC: 12.4.2 or higher)	Check (P) box and (V) is displayed in the field. Insight will automatically assign an address to this virtual point.
Engineering Unit	MMBtu
COV Limit	At least equal to Gain number of the above LPACI point
Initial Value	0
Totalization	Hourly
	Leave all other items at their default value and click “OK.”

Step 3. Add a programming step to update the accumulated monthly consumption value every 15 minutes.

In Insight Apogee, perform the following steps:

a. Select "Program Editor". Then in the Program Menu select "New".
b. Enter the PPCL program lines (See Appendix A) in the new program window editor that is displayed. Press enter at the end of each program line.
c. From Program Menu select "Save As". The Save As dialog box will be displayed.

Set the following parameters as specified below:

System Name	Enter a unique name up to 30 characters in length. For example, BLDG1.consumption
Name	Enter a unique name up to 30 characters in length. For example, BLDG1.consumption
Field Panel	Click the button to show a list of field panels on the network, then select the name of the field panel that contains the point
	Click "OK"

Step 4. Create the trend point extension on the internal analog output point in EMCS to record accumulated consumption values every 15 minutes.

In Insight Apogee, perform the following steps:

a. Select “Trend Definition Editor”. From the Trend Menu select “New”.
b. The Object Selector will be displayed. Select the LAO point above, and click “OK”.
c. The Trend Type dialog box will be displayed. Select “COV”, and click “OK”.
d. The Add COV Definition dialog box will be displayed. Set the parameters as specified below:

Panel Samples Desired	300 samples (Panel can keep data for 3 days) or the Maximum Samples available at Panel, whichever is less
Trend COV Limit	Select “Use Trend COV Limit” with 0.01 value
PC Buffer size	1000 (PC can keep data for 10 days) or the maximum Insight Storage number, whichever is less
Enable PC Collection	Check this box to enable PC for data collection
Enable “COV Buffer Full” Notification	Check this box to enable control panel to notify Insight when the trend buffer has reached 80% full
	Click “OK” to close the Add COV Definition dialog box
	Click “OK” to the Operation Successful message

Application D. Thermal Consumption Monitoring Using an EMCS

Charts D-1 through D-4 will provide the user with steps to set-up an EMCS to monitor thermal consumption. By following these steps, the user will enable the EMCS to measure thermal consumption (MMBtu) and store fifteen-minute data. Chart D-1 lists the needed equipment and will help the user determine if the controller has an available input slot. Chart D-2 aids the user in choosing temperature sensors and a flow meter. The chart lists the temperature sensor and flow meter accuracy and output type. Tips for temperature sensor and flow meter installation are provided as well. Chart D-3 provides an example of a temperature sensor and a flow meter available in the market. Chart D-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly thermal consumption. The user should then proceed to Application F to set-up the data collection and history data storage.

Step 1. Check the input slot availability on the controller.

Use Chart D-1 to find which slots are needed on the controller. The position of the slot can be found in Chart D-1 under Controller Terminal Connections. For example, the SCU needs three available slots either on AI-00 to AI-15 on TB2, TB3, TB4 or TB5. If there are no available slots, contact a Siemens representative to determine whether an expansion I/O module can be added to this controller or if an additional controller should be installed.

Step 2. Choose a Temperature Sensor and Flow Meter.

Chart D-2 lists the temperature sensor and flow meter specifications. For example, an acceptable temperature sensor and flow meter for SCU should have analog output and either current or voltage output. The recommended accuracy for a chilled water temperature sensor is 0.2 °F, while the recommended accuracy for a hot water temperature sensor is 0.5 °F. The end-to-end accuracy of this thermal measurement does not depend only on the meter and sensors but also the characteristics of the system (differential temperature). Chart D-2 and Appendix B provide more information regarding this. Chart D-3 shows an example of temperature sensors and a flow meter provided in the market.

Step 3. Follow the EMCS programming steps.

Chart D-4 provides the steps to set-up the external input points (from the temperature sensor and flow meter) and internal points used to store the consumption that the EMCS must recognize. Detailed steps provided in this chart must be followed in order to set-up the external input point and internal points.

Step 4. Follow the steps in Application F.

Application F lists the steps to set-up the data collection and history data storage.

After these steps are complete, the system can collect and store monthly thermal consumption data.

Chart D-1. Thermal Consumption Monitoring Using EMCS

Verify that in addition to the sensors and transducer, the controller has the available slots as discussed below.

<table>
<tr><th></th><th>MBC</th><th>RBC</th><th>MEC</th><th>SCU</th><th>UC</th></tr>
<tr><td>What is measured</td><td colspan="5">• Chilled/Hot water flow
• Chilled/Hot water supply and return temperature</td></tr>
<tr><td>What is stored in EMCS</td><td colspan="5">• Fifteen-minute data of Thermal Consumption in MMBtu units stored in Trend Data History</td></tr>
<tr><td>What is needed</td><td colspan="5">1 – Flow meter
2 – Temperature sensors
3 – available slot on Terminal Block (for external analog input)
1 – available internal analog output point (to calculate instantaneous thermal consumption)
1 – available internal analog output point (to accumulate month-to-date consumption)</td></tr>
<tr><td>Terminal Block for Current Analog Input</td><td colspan="2">PTM6.2I420</td><td rowspan="2">AI 17 – AI 24</td><td rowspan="2">TB2-5
AI-00 to AI-15</td><td rowspan="2">I/O card1: UI13–UI16
I/O card2: UI33–UI36</td></tr>
<tr><td>Terminal Block for Voltage Analog Input</td><td colspan="2">PTM6.2U10</td></tr>
</table>

Chart D-2. Thermal Consumption Monitoring Using EMCS

Flow Meter and Temperature Sensor Specifications

<table>
<tr><th></th><th>MBC</th><th>RBC</th><th>MEC</th><th>SCU</th><th>UC</th></tr>
<tr><td>Output Type from Flow Meter</td><td colspan="5">Analog, either voltage or current output</td></tr>
<tr><td>Output Type from Temperature Sensors</td><td colspan="5">Analog, current output</td></tr>
<tr><td>Maximum Wire Length (ft.)</td><td colspan="5">750 ft. @ 14-22 AWG</td></tr>
<tr><td>Temperature Sensor Accuracy</td><td colspan="5">• Recommended accuracy for chilled water temperature sensor: ± 0.2 °F
• Recommended accuracy for hot water temperature sensor: ± 0.5 °F</td></tr>
<tr><td>Flow Meter Accuracy</td><td colspan="5">• Recommended accuracy for flow meter 1% full scale</td></tr>
<tr><td>End-To-End Accuracy</td><td colspan="5">The end-to-end accuracy depends on the accuracy of temperature sensors, flow meter and how large the temperature difference is. Assuming the difference between the chilled water supply and return temperature is 10 °F, the end-to-end accuracy can approach 5%. Assuming the difference between hot water supply and return temperature is 20 °F, the accuracy can approach 7%, without end-to-end calibration. See Appendix B</td></tr>
</table>

Notes on installation:

- Install flow meter on the supply pipe or the return pipe.
- Install matched temperature sensors, one on the supply pipe and another on the return pipe.
- For the temperature sensor on the same pipe as the flow meter, install the sensor close to the flow meter.
- Disconnect the flow meter and temperature sensors at the Terminal Block. Follow the manufacturer’s instructions.

Chart D-3. Thermal Consumption Monitoring Using an EMCS

An Example of Flow Meter and Temperature Sensor Specifications

The following Flow Meter and Temperature sensors have been used successfully.

Temperature Sensor		
Minco Products, Inc		
RTD with TempTran transmitter		
Input	Temperature Range	30-80 °F (for chilled water system)
Output	Standard Output	Current, 4-20 mA
	Accuracy	± 0.2 % of span

Flow Meter and Transmitter		
Rosemount		
8705 with the integral mounted type transmitter model 8732		
Input	Flow Rate	0.04 to 30 ft./sec
	Maximum Pressure	285 psi @ 100°F
	Temperature Condition	Natural Rubber Lining: 0 to 185 °F
	Minimum Liquid Conductivity	5 microsiemens/cm
Output	Standard Output	Current, 4-20 mA
	Accuracy	± 0.5% of rate from 1 to 30 ft/sec and ± 0.005 ft/sec from 0.04 to 1 ft/sec

Chart D-4. Thermal Consumption Monitoring Using EMCS

EMCS Programming Steps

Summary

1. Set-up external analog input (LAI) points in EMCS for flow meter and temperature sensors.
2. Set-up an internal analog output (LAO) point to store the instantaneous consumption value.
3. Add a programming step that will use the LAI points from Step 1 to calculate for instantaneous consumption and store the LAO point value from Step 2.
4. Set-up an internal analog output (LAO) point to collect monthly consumption data.
5. Add a programming step to update the point in Step 4 every 15 minutes.
6. Create a Trend point extension on the internal analog output point in EMCS to record consumption values every 15 minutes.

Details of these steps follow.

Step 1. Set-up external analog input (LAI) points in EMCS for flow meter and temperature sensors.

In Insight Apogee, perform the following steps: Connect the installed sensors to the controller.

a. Select “Point Editor”. In the Point Menu, select “New” then “LAI (Logical Analog Input)”.

b. The new point window editor will be displayed. Set the following parameters as specified below:

<table>
<tr><td>System Name</td><td colspan="4">Enter a name up to 30 characters in length. For example, BLDG1.therm</td></tr>
<tr><td>Point Name</td><td colspan="4">Enter a name up to 30 characters in length. For example, BLDG1.chwmmbtu1</td></tr>
<tr><td>Field Panel</td><td colspan="4">Click the button to show a list of field panels on the network, then select name of the field panel that contains the point</td></tr>
<tr><td>Descriptor</td><td colspan="4">Enter up to 16 characters in length to provide some additional explanation about the application or location of the point</td></tr>
<tr><td rowspan="2">Address for current firmware revision (MBC/RBC: 2.0 or higher, SCU/UC: 12.4.2 or higher)</td><td colspan="4">L . DDD . PPPPP
L: FLN number, 0-3
D: Drop number, 0-099
P: Point number, 0-65,000</td></tr>
<tr><td>L is equal to 0.
D is the address key number in the PTM (Point Termination Module).
P is the actual hardware layout number.</td><td>L is equal to 0.
D is equal to 0 if point resides in MEC, or FLN number
P can be 17-24.</td><td>L is equal to 0.
D is the termination board number.
P is the termination point number.</td><td>L is FLN connecting number on field panel
D is FLN device number.
P is the termination point number.</td></tr>
<tr><td>Engineering Unit</td><td colspan="4">GPM for flow meter and °F for temperature sensors</td></tr>
<tr><td>Slope/Intercept</td><td colspan="4">Choose Slope/Intercept button to open Slope Intercept Calculator dialog box with the following parameters</td></tr>
<tr><td>Calculate Based On</td><td>MBC/RBC</td><td>MEC</td><td>SCU</td><td>UC</td></tr>
<tr><td>Sensor Type</td><td colspan="4">Current or Voltage depend on input type</td></tr>
<tr><td>Calculate Using</td><td colspan="4">English</td></tr>
<tr><td>Signal Range</td><td colspan="4">Low Value: 4 for current and 0 for voltage
High Value: 20 for current and 5 or 10 for voltage</td></tr>
<tr><td>Device Range</td><td colspan="4">Low Value: the kW value corresponding to the low signal from sensor
High Value: the kW value corresponding to the high signal from sensor
For instance, the Temperature sensor is set-up to send out signal of 30 °F at 4 mA and 90 °F at 20 mA, the low value in this case is 30 and the high value is 90.</td></tr>
</table>

	• Click “Calculate” button to calculate the slope and intercept value
	• Click “OK” to return to point window
COV Limit	10 times of slope value
Sensor Type	Current or Voltage depend on input type
Totalization Rate	None
	• From the Point menu, select “Save”
	• Repeat the same procedure to set-up internal analog inputs points for flow meter and temperature sensors

<u>Step 2</u>. Set-up an internal analog output (LAO) point in EMCS to store the instantaneous consumption value.

In Insight Apogee, perform the following steps:

a. Select “Point Editor”. In the Point Menu select “New” then “LAO (Logical Analog Output).

b. The new point window will be displayed. Set the following parameters as specified below:

System Name	Enter a name up to 30 characters in length. For example, BLDG1.therm
Point Name	Enter a name up to 30 characters in length. For example, BLDG1.chwmmbtuph1
Field Panel	Click the button to show a list of field panels on the network, then select name of the field panel that contains the point
Descriptor	Enter up to 16 characters in length to provide some additional explanation about the application or location of the point
Address for current firmware revision (MBC/RBC: 2.0 or higher, SCU/UC: 12.4.2 or higher)	Check (P) box and (V) is displayed in the field. Insight will automatically assign an address to this virtual point.
Engineering Unit	MMBtu/hr
COV Limit	0.01
Initial Value	0
Totalization Rate	Hourly
	• Leave all other items at their default value and click “OK.”

Step 3. Add a programming step that will use the LAI points from Step 1 to calculate for instantaneous consumption and store the LAO point value from Step 2.

In Insight Apogee, perform the following steps:

a. Select “Program Editor” Then in the Program Menu select “New”.
b. In the new program window editor displayed, enter the PPCL program lines (See Appendix C). Press enter at the end of each program line.
c. From Program Menu select “Save As”. The Save As dialog box will be displayed.

Set the following parameters as specified below:

System Name	Enter a unique name up to 30 characters in length. For example, BLDG1.consumption
Name	Enter a unique name up to 30 characters in length. For example, BLDG1.consumption
Field Panel	Click the button to show a list of field panels on the network, then select the name of the field panel that contains the point
	Click “OK”

Step 4. Set-up an internal analog output (LAO) point to collect monthly consumption data.

	Follow the procedure of how to set-up an internal analog output point in EMCS to store instantaneous consumption from internal EMCS calculation, except for the following parameter
Engineering Unit	MMBtu

Step 5. Add a programming step to update the point in Step 4 every 15 minutes.

In Insight Apogee, perform the following steps:

a. Select "Program Editor". Then in the Program Menu, select "New".
b. Enter the PPCL program lines (See Appendix A) in the new program window editor. Press Enter at the end of each program line.
c. From Program Menu select "Save As". This will display the Save As dialog box. Set the following parameters as specified below:

System Name	Enter a unique name up to 30 characters in length. For example, BLDG1.consumption
Name	Enter a unique name up to 30 characters in length. For example, BLDG1.consumption
Field Panel	Click the button to show a list of field panels on the network, then select the name of the field panel that contains the point
	• Click "OK"

Step 6. Create Trend point extension on the internal analog output point in EMCS to record consumption values every 15 minutes.

In Insight Apogee, perform the following steps:

a. Select “Trend Definition Editor”. From the Trend Menu, select “New”.
b. In the Object Selector display, select the LAO point above, and click “OK”.
c. Select “COV” in the Trend Type dialog box display, and click “OK”.
d. The Add COV Definition box will be displayed.

Set the following parameters as specified below:

Panel Samples Desired	300 samples (a panel can keep data for 3 days) or the Maximum Samples available at a panel, whichever is less
Trend COV Limit	Select “Use Trend COV Limit” with 0.01 value
PC Buffer size	1000 (PC can keep data for 10 days) or the maximum Insight Storage number, whichever is less
Enable PC Collection	Check this box to enable PC for data collection
Enable “COV Buffer Full” Notification	Check this box to enable control panel to notify Insight when the trend buffer has reached 80% full
	Click “OK” to close the Add COV Definition dialog box
	Click “OK” to the Operation Successful message

Application E. Room Temperature Monitoring

Charts E-1 through E-4 will take the user through steps to set-up a temperature sensor to monitor room temperature. Following these steps will enable the EMCS to measure room temperature (°F) and store fifteen-minute data. Chart E-1 lists the needed equipment and will help the user determine if the controller has an available input slot. Chart E-2 aids the user in choosing a temperature sensor. The chart lists each type of output from sensor accuracy for different controller models. The chart also lists wire and sensor specifications. Chart E-3 provides an example of a temperature sensor available in the market. Chart E-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to display current temperature and record 15-minute temperature. The user should then proceed to Application F to set-up the data collection and history data storage.

Step 1. Check the input slot availability on the controller.

Use Chart E-1 to find which slots are needed on the controller. The position of the slot can be found in Chart E-1 under Controller Terminal Connections. There are three types of temperature sensor inputs acceptable in most controllers: current, voltage and thermistor. Any of these inputs can be chosen depending on the application. For example, UC has two input/output cards that have four terminal connections each. One slot is needed on UI13-UI16 on I/O card1 or UI33-UI36 on I/O card2 for a current or voltage temperature sensor. If there are no available slots, contact a Siemens representative to determine whether an expansion I/O module can be added to this controller or if an additional controller should be installed.

Step 2. Choose a Temperature Sensor.

Chart E-2 lists the temperature sensor specifications. For example, an acceptable temperature sensor for UC should have current or voltage output with ± 1.0 °F accuracy or better. The end-to-end accuracy from the temperature sensor to the UC controller could be around ± 1.5 °F. Note that to gain this accuracy the temperature sensor must be placed no more than 750 ft. away with 14-22 AWG type wire. If this accuracy is not acceptable, a temperature sensor with better accuracy is needed or the controller must be replaced. Chart E-3 shows an example of a temperature sensor provided in the market.

Step 3. Follow the EMCS programming steps.

Chart E-4 provides the steps to set-up the external input point (from the sensor) the EMCS must recognize. Detailed steps provided in this chart must be followed to set-up the external input point.

Step 4. Follow the steps in Application F.

Application F lists the steps to set-up the data collection and history data storage.

After these steps are complete, the system can display the current temperature and record 15-minute temperature data.

Chart E-1. Room Temperature Monitoring

Verify that in addition to the sensors, the controller has the available slots as discussed below.

<table>
<tr><th></th><th>MBC</th><th>RBC</th><th>MEC</th><th>SCU</th><th>UC</th></tr>
<tr><td>What is measured</td><td colspan="5">Room temperature</td></tr>
<tr><td>What is stored in EMCS</td><td colspan="5">Fifteen-minute data of room temperature in °F stored in Trend Data History</td></tr>
<tr><td>What is needed</td><td colspan="5">1 – Temperature sensors
1 – Available slot on Terminal Block (depending on output type of each devices)</td></tr>
<tr><td>Terminal Block for Current Analog Input</td><td colspan="2">PTM6.2I420</td><td rowspan="2">AI 17 – AI 24</td><td rowspan="3">TB2-5
AI-00 to AI-15</td><td rowspan="2">I/O card1: UI13–UI16
I/O card2: UI33–UI36</td></tr>
<tr><td>Terminal Block for Voltage Analog Input</td><td colspan="2">PTM6.2U10</td></tr>
<tr><td>Terminal Block for Thermistor Analog Input</td><td colspan="2">PTM6.2N100K</td><td>N/A</td><td>N/A</td></tr>
</table>

Chart E-2. Room Temperature Monitoring

Temperature Sensor Specifications

	MBC	RBC	MEC	SCU	UC
Output Type from Temperature Sensors	Analog, current, voltage or thermistor output				
Accuracy from Temperature Sensors	The recommended accuracy for the room temperature sensor is ± 1.0 °F. Depending on the application, this accuracy may be lower.				
End-to-end Accuracy for current output*	± 1.0 °F plus the accuracy of MBC/RBC current reading		± 1.0 °F plus the accuracy of MEC current reading	± 1.0 °F plus the accuracy of SCU current reading	± 1.5 °F
End-to-end Accuracy for voltage output*	± 1.0 °F plus the accuracy of MBC/RBC voltage reading		± 1.0 °F plus the accuracy of MEC voltage reading	± 1.0 °F plus the accuracy of SCU voltage reading	± 1.5 °F
End-to-end Accuracy for thermistor output	± 1.0 °F plus the accuracy of MBC/RBC thermistor reading		N/A	± 1.0 °F plus the accuracy of SCU thermistor reading	N/A
Maximum Wire Length (ft.)	750 ft. @ 14-22 AWG				

* Temperature reading is range from 0 – 100 °F

Chart E-3. Room Temperature Monitoring

<u>Example of Temperature Sensor Specification</u>

Temperature Sensor		
Vaisala		
HMD 60 Y, Duct Temperature Transmitter		
Input	Temperature Range	-20 to 80 °C
Output	Standard Output	Current, 4-20 mA
	Accuracy	± 0.6 °C over the span
	Linearity	0.1 °C or better

Chart E-4. Room Temperature Monitoring

EMCS Programming Steps

Summary

1. Set-up the external analog input (LAI) points in the EMCS for the room temperature sensor.
2. Set-up an analog output (LAO) point to store the instantaneous consumption value.
3. Add a programming step to update the point value created in Step 2 every 15 minutes.
4. Create a trend point extension on the internal analog output point in the EMCS to record the room temperature every 15 minutes.

Details of these steps follow.

<u>Step 1</u>. Set-up the external analog input (LAI) points in the EMCS for the room temperature sensor.

In Insight Apogee, perform the following steps:

a. Connect the installed sensors to the controller
b. Select “Point Editor”, then in the Point Menu select “New”, then “LAI (Logical Analog Input)”
c. The new point window will be displayed.

Set the following parameters as specified below:

<table>
<tr><td>System Name</td><td colspan="4">Enter a name up to 30 characters in length. For example, BLDG1.Rm101</td></tr>
<tr><td>Point Name</td><td colspan="4">Enter a name up to 30 characters in length. For example, BLDG1.temp1</td></tr>
<tr><td>Field Panel</td><td colspan="4">Click the button to show a list of field panels on the network, then select name of the field panel that contains the point</td></tr>
<tr><td>Descriptor</td><td colspan="4">Enter up to 16 characters in length to provide some additional explanation about the application or location of the point</td></tr>
<tr><td rowspan="2">Address for current firmware revision (MBC/RBC: 2.0 or higher, SCU/UC: 12.4.2 or higher)</td><td colspan="4">L . DDD . PPPPP
L: FLN number, 0-3
D: Drop number, 0-099
P: Point number, 0-65,000</td></tr>
<tr><td>L is equal to 0.
D is the address key number in the PTM (Point Termination Module).
P is the actual hardware layout number.</td><td>L is equal to 0.
D is equal to 0 if point resides in MEC, or FLN number
P can be 17-24.</td><td>L is equal to 0.
D is the termination board number.
P is the termination point number.</td><td>L is FLN connecting number on field panel
D is FLN device number.
P is the termination point number.</td></tr>
<tr><td>Engineering Unit</td><td colspan="4">°F</td></tr>
<tr><td>Slope/Intercept</td><td colspan="4">Choose Slope/Intercept button to open Slope Intercept Calculator dialog box with the following parameters</td></tr>
<tr><td>Calculate Based On</td><td>MBC/RBC</td><td>MEC</td><td>SCU</td><td>UC</td></tr>
<tr><td>Sensor Type</td><td colspan="4">Current or Voltage depend on input type</td></tr>
<tr><td>Calculate Using</td><td colspan="4">English</td></tr>
<tr><td>Signal Range</td><td colspan="4">Low Value: 4 for current and 0 for voltage
High Value: 20 for current and 5 or 10 for voltage</td></tr>
</table>

Device Range	Low Value: the kW value corresponding to the low signal from sensor High Value: the kW value corresponding to the high signal from sensor For instance, Temperature sensor is set-up to send out signal of 40 °F at 4 mA and 120 °F at 20 mA. The low value in this case is 40 and the high value is 120.
	• Click “Calculate” button to calculate the slope and intercept value
	• Click “OK” to return to point window
COV Limit	0.1
Sensor Type	Current or Voltage depending on input type
Totalization Rate	None
	• From the Point menu, select “Save”
	• Repeat the same procedure to set-up internal analog inputs points for flow meter and temperature sensors

<u>Step 2</u>. Set-up an analog output (LAO) point to store the instantaneous consumption value.

In Insight Apogee, perform the following steps:

a. Select “Point Editor”, then in the Point Menu select “New”, then “LAO (Logical Analog Output)”

b. A new point window editor will be displayed. Set the following parameters as specified below:

System Name	Enter a name up to 30 characters in length. For example, BLDG1.Rm1
Point Name	Enter a name up to 30 characters in length. For example, BLDG1.rm1temp1
Field Panel	Click the button to show a list of field panels on the network, then select name of the field panel that contains the point
Descriptor	Enter up to 16 characters in length to provide some additional explanation about the application or location of the point
Address for current firmware revision (MBC/RBC: 2.0 or higher, SCU/UC: 12.4.2 or higher)	Check (P) box and (V) is displayed in the field. Insight will automatically assign an address to this virtual point.
Engineering Unit	°F
COV Limit	0.1
Initial Value	0
Totalization Rate	None
	Leave all other items at their default value and click “OK.”

Step 3. Add a programming step to update the point value created in Step 2 every 15 minutes.

In Insight Apogee, perform the following steps:

a. Select "Program Editor". Then in the Program Menu, select "New".

b. In the new program window editor, enter the PPCL program lines (See Appendix A). Press enter at the end of each program line.

c. From the Program Menu, select "Save As" and the Save As dialog box will be displayed. Set the following parameters as specified below:

System Name	Enter a unique name up to 30 characters in length. For example, BLDG1.rm1temp
Name	Enter a unique name up to 30 characters in length. For example, BLDG1.rm1temp1
Field Panel	Click the button to show a list of field panels on the network, then select name of the field panel that contains the point
	Click "OK"

Step 4. Create trend point extension on the internal analog output point in EMCS to record the room temperature every 15 minutes.

In Insight Apogee, perform the following steps:

a. Select "Trend Definition Editor". From the Trend Menu, select "New".

b. In the Object Selector displayed, select the LAO point above and click "OK".

c. The Trend Type dialog box will be displayed. Select "COV" and click "OK".

d. The Add COV Definition dialog box will be displayed. Set the following parameters as specified below:

Panel Samples Desired	300 samples (Panel can keep data for 3 days) or the Maximum Samples available at Panel, whichever is less
Trend COV Limit	Select "Use Trend COV Limit" with 0.01 value
PC Buffer size	1000 (PC can keep data for 10 day) or the maximum Insight Storage number, whichever is less
Enable PC Collection	Check this box to enable PC for data collection
Enable "COV Buffer Full" Notification	Check this box to enable control panel to notify Insight when the trend buffer has reached 80% full
	• Click "OK" to close the Add COV Definition dialog box
	• Click "OK" to the Operation Successful message

Application F. Data Collection Configuration and Storage in Insight and Data Collection and Archiving in Infocenter

There are three parts in the data collection process. First, the Trend Definition collects data in the controller memory and directs it to the PC Insight Workstation. A limited amount of data will be saved in the Workstation as specified in the Trend Definition. When the amount of data reaches that limit, the new data will overwrite the old data. The second part of the data collection process involves storing historical data to avoid data loss. This is achieved by setting up Trend Sample Report and scheduling Trend Collection and Report Collection. The generated reports contain the history data and will be saved under a specific directory that is recognized by Infocenter. Import Definition and Archive Schedule will then be set-up. The Import Definition will transfer the point data file from PC workstation to the InfoCenter Server. Here the point data records can be retained indefinitely or for a specified time interval after which they can be archived to disk-based media for long-term storage. The Archive Schedule is set-up to move data periodically and automatically to off-line storage. Archived data can still be viewed and exported along with the most current data.

Step 1. Set-up a Trend Sample Report.

Follow the steps below to set-up a Trend Sample Report. This will create a report that displays all values collected for the selected points.

In Report Builder, perform the following steps:

a. From the Definition menu, select “New”.
b. From the list, select “Trend Sample Report”.
c. Click “OK”.
d. Under Trend Points, click “Configure”.
e. Click “Add” to add trend points and the object selector window will be displayed.
f. Click “Find Now” and select the points to be trended. When complete, click “OK”.
g. Click “OK” on the object selector window.
h. Under Output, click “Configure”.

i. Check "File" box in the Report Output Options dialog box. Enter a file name and path this report will be saved to.

Step 2. Schedule a Trend Collection.

Follow the steps below to schedule a Trend Collection. This will upload the trend data of the specified points in the trend collection report definition from the field panel to the Insight PC.

In Scheduler, perform the following steps:

a. From the daily tab, select a starting day.
b. From the schedule menu, select "New" then "Trend Collection". The object selector will be displayed.
c. Click "Find Now" and select the trend collection report to be displayed. Then click "OK".
d. The Add Trend Collection Schedule dialog box will be displayed.
e. Enter the starting date of the trend collection time in Schedule Date.
f. Enter the starting time of trend collection in Collection Time.
g. Check the "Enabled" box to allow the trend collection.
h. Under Repetition, choose frequency to be "Daily" and select "Continuous". Then click "OK".

Step 3. Schedule a Report Collection.

Follow the steps below to schedule a Report Collection to create a report. This report will contain the data stored at the defined output destination for the scheduled date and time. This report will be a part of the database in Infocenter.

In Scheduler, perform the following steps:

a. From the daily tab, select a starting day.
b. From the schedule menu, select "New" then "Report". The object selector will be displayed.
c. Click "Find Now" and select the report to be scheduled. Then click "OK".
d. The Add Report dialog box displays.
e. Enter the starting date of the report time in Scheduled Date.
f. Enter the starting time of report in Execution Time.

g. Check the “Enabled” box to allow the report schedule.
h. Under Repetition, choose frequency to be “Daily” and select “Advanced Button”.
i. Check “Delimited Text”, “Overwrite File”, then click “OK”.

Step 4. Set-up Import Definition.

Follow the steps below to set-up an Import Definition to import data from Insight Workstation into InfoCenter Server.

In the InfoCenter Administrator Import Definition view, perform the following steps:

a. Click “New”. The New Import dialog box appears.
b. Enter an import definition name in the Import Name field.
c. Enter any comments regarding the import definition in the Description field.
d. Click “Automatically” to allow the InfoCenter Server to collect data whenever a new data file is written to the import directory.
e. Select “CSV” as the format of the import data.
f. Type the path and file name of the data file to be imported in the From File field.
g. To assign InfoCenter Server point attributes to a point, select the point or cell and click “Properties”.
h. Click “OK”.

Step 5. Set-up Archive Schedule.

Follow the steps below to set-up an Archive Schedule to move point data record from the active server to an off-line disk-based storage.

In the InfoCenter Administrator Archive Schedules view, perform the following steps:

a. Click “New”. The New Archive Schedule dialog box appears.
b. Enter an archive schedule name in the Schedule Name field.
c. Enter any comments regarding the new archive schedule in the Description field.
d. Check “Enabled” box to automatically move the data records.
e. Select the intermediary volume where the data records will be archived from the Archive Point Data Records to Intermediary Volume list.
f. Select “Weekly” Frequency and On “Sunday”.
g. Under Retention Period, click the “Months” option and enter “12” in the space to retain the data record for 12 months in the Active Volume.

h. Under Points, click “Add Points” and select points whose data records are to be archived from the Select Point dialog box.
i. Click “OK”.

APPENDICES

Appendix A: Data Logging Program

Appendix B: Thermal Consumption Accuracy

Appendix C: Thermal Consumption Calculation Program

Appendix A: Data Logging Program

Insight offers a data logging feature for each point in the controller. There are two methods Trend Definition can use to record data. One method is to set the point in Trend Definition to record data at specific time intervals (such as at the top of the hour or quarters of the hour). The other method is to set the point in Trend Definition to record the data when the value of the point changes by a specified amount. For electrical monitoring, it is preferred to record data at a specified time interval (every 15 minutes) at the top of every hour. Once the point recognizes the Trend Definition, it is guaranteed the data will be recorded every 15 minutes. However, this does not necessarily occur at the top of the hour. One of several solutions is the following program. This program will store the monitoring value to another parameter every 15 minutes starting at the top of the hour. Using the change of value method to store data, the Trend Definition will be assigned to the new parameter. We will get trend history of the monitored value every 15 minutes starting at the top of the hour.

Assume we would like to have electrical consumption trended every 15 minutes starting at the top of the hour. We would use the following parameters in the program:

- *Bldg1.kw* is the electrical demand reading in kW unit from the Watt Transducer.
- *Bldg1.kwhr15* is the electrical consumption in kWh unit recorded with 15 minute intervals starting at the top of the hour.
- *Bldg1.nexttime* is the Next Time recording the data.
- *Bldg1.const* is the Constant time increment value, 0.25 (15 minutes in decimal unit).
- *UCM.Bldg1.kwhr* is the electrical consumption parameter in kWh unit, which will be used in Utility Cost Manager to calculate for the billing in each month.

```
00001  C Beginning of the Program
00005  C Line 10 is to reset the BLDG1.NEXTTIME parameter to 0.0 within 1 minute 48 seconds after midnight of each day
00010  IF(CRTIME .GE. 0.0 .AND. CRTIME .LE. 0.03 .AND. "BLDG1.NEXTTIME" .GE. 24.0) THEN "BLDG1.NEXTTIME" = 0.0
00015  C If Current Time is Less Than BLDG1.NEXTTIME value, go to line 90 and no 15-minutes electrical consumption is updated
00020  IF(CRTIME .LT. "BLDG1.NEXTTIME") THEN GOTO 90
00025  C Line 30 is to set the next time that 15-minutes electrical consumption will be updated
00030  "BLDG1.NEXTTIME" = "BLDG1.NEXTTIME" + "BLDG1.CONST"
00035  C BLDG1.KWHR15 is the accumulation of electrical demand BLDG1.KW updated every 15 minutes
00040  "BLDG1.KWHR15" = TOTAL("BLDG1.KW")
00045  C Line 50 is to prevent the possibility of having decrement consumption value
00050  IF("BLDG1.KWHR15" .GE. "UCM.BLDG1.kwhr") THEN "UCM.BLDG1.kwhr" = "BLDG1.KWHR15" ELSE "UCM.BLDG1.kwhr" =
       "UCM.BLDG1.kwhr"
00055  C At the end of each month, BLDG1.KWHR and UCM.BLDG1.kwhr will be reset to 0 within 1 minute and 12 seconds before
       midnight
00060  IF(MONTH .EQ. 1 .OR. MONTH .EQ. 3 .OR. MONTH .EQ. 5 .OR. MONTH .EQ. 7 .OR. MONTH .EQ. 8 .OR. MONTH .EQ. 10 .OR. MONTH
       .EQ. 12) THEN GOTO 90
00070  IF(MONTH .EQ. 4 .OR. MONTH .EQ. 6 .OR. MONTH .EQ. 9 .OR. MONTH .EQ. 11) THEN GOTO 110
00080  IF(MONTH .EQ. 2) THEN GOTO 130
00090  IF(DAYOFM .EQ. 31 .AND. CRTIME .GT. 23.98) THEN INITTO(0.0,"BLDG1.KWHR","UCM.BLDG1.kwhr")
00100  GOTO 10
00110  IF(DAYOFM .EQ. 30 .AND. CRTIME .GT. 23.98) THEN INITTO(0.0,"BLDG1.KWHR","UCM.BLDG1.kwhr")
00120  GOTO 10
00130  IF(DAYOFM .EQ. 28 .AND. CRTIME .GT. 23.98) THEN INITTO(0.0,"BLDG1.KWHR","UCM.BLDG1.kwhr")
00140  GOTO 10
```

Appendix B: Thermal Consumption Accuracy

The accuracy of thermal consumption depends on the temperature sensor accuracy, the flow meter accuracy and the temperature difference as shown in the following tables. Each table represents the thermal consumption calculation accuracy based on a specific temperature difference and combinations of temperature sensor accuracy and flow meter accuracy. For example, if a chilled water system has a temperature difference between the supply and return at 8°F and we would like to control the thermal consumption accuracy to be below 10%, we can select several combinations of temperature sensors and flow meter from the accuracy shown in Table B.2. We can choose a temperature sensor at 0.2 or at 0.5°F accuracy with a flow meter of 0.5, 1 or 2% accuracy. For instance, a combination of temperature sensors with 0.5 °F accuracy, a flow meter with 2% accuracy, and an 8°F temperature difference, yield a thermal consumption calculation accuracy of 8.38%. A better accuracy can be achieved with a more accurate temperature sensor, a more accurate flow meter, or a higher difference in temperature. The thermal consumption accuracy of the above example can be improved from 8.38% to 4.55% using a temperature sensor with 0.2°F accuracy. Note that the above accuracy has not included the accuracy from the controller reading, signal loss along the wire, etc. The accuracy only takes the temperature sensor and flow meter into account.

Table B.1 Thermal Consumption Calculation Accuracy Based on 5°F Temperature Difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	4.52 %	10.55 %	20.60 %	40.70 %
1	5.04 %	11.10 %	21.20 %	41.40 %
2	6.08 %	12.20 %	22.40 %	42.80 %

Table B.2 Thermal Consumption Calculation Accuracy Based on 8 °F Temperature Difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	3.01 %	6.78 %	13.06 %	25.63 %
1	3.53 %	7.31 %	13.63 %	26.25 %
2	4.55 %	8.38 %	14.75 %	27.5 %

Table B.3 Thermal Consumption Calculation Accuracy Based on 10 °F Temperature Difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	2.51 %	5.53 %	10.55 %	20.60 %
1	3.02 %	6.05 %	11.10 %	21.20 %
2	4.04 %	7.10 %	12.20 %	22.40 %

Table B.4 Thermal Consumption Calculation Accuracy Based on 12 °F Temperature Difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	2.18 %	4.69 %	8.88 %	17.25 %
1	2.68 %	5.21 %	9.42 %	17.83 %
2	3.70 %	6.25 %	10.50 %	19.00 %

Appendix C: Thermal Consumption Calculation Program

Supply and return water temperature and their flow rates are obtained for thermal consumption calculation. The following formula is used to determine a thermal energy usage applicable to chilled water and hot water systems.

- *Bldg1.cwrt* is the measured Chilled Water Return Temperature in °F.
- *Bldg1.cwst* is the measured Chilled Water Supply Temperature in °F.
- *Bldg1.cwflo* is the measured Chilled Water Flow rate in GPM.
- *Bldg1.cwdt* is the calculated Chilled Water Differential Temperature.
- *Bldg1.chwgpm* is the Chilled Water flow rate in GPM.
- *Bldg1.cwrtc* is the calculated Chilled Water Return Temperature in °C.
- *Bldg1.T2* is chilled water return Temperature in °C power of 2.
- *Bldg1.T3* is chilled water return Temperature in °C power of 3.
- *Bldg1.T4* is chilled water return Temperature in °C power of 4.
- *Bldg1.T5* is chilled water return Temperature in °C power of 5.
- *Bldg1.chwdensity* is the calculated Chilled Water Density.
- *Bldg1.cmmbtu* is the calculated Chilled water consumption in MMBtu.
- $LOC1 and $LOC2 are temporary intermediate variables.

```
00010  "BLDG1.CWDT" = "BLDG1.CWRT" - "BLDG1.CWST"
00015  C If BLDG1.CWDT is negative, set this differential temperature parameter to zero to prevent the negative value in
       consumption calculation
00020  IF("BLDG1.CWDT" .LE. 0.0) THEN SET(0.0,"BLDG1.CWDT")
00030  "BLDG1.CHWGPM" = "BLDG1.CWFLO"
00035  C If BLDG1.CHWGPM is negative, set this flow rate parameter to zero to prevent the negative value in consumption
       calculation
00040  IF("BLDG1.CHWGPM" .LE. 0.0) THEN SET(0.0,"BLDG1.CHWGPM")
00050  "BLDG1.CWRTC" = ("BLDG1.CWRT" - 32) * 5 / 9
00060  "BLDG1.T2" = "BLDG1.CWRTC" * "BLDG1.CWRTC"
00070  "BLDG1.T3" = "BLDG1.CWRTC" * "BLDG1.CWRTC" * "BLDG1.CWRTC"
00080  "BLDG1.T4" = "BLDG1.CWRTC" * "BLDG1.CWRTC" * "BLDG1.CWRTC" * "BLDG1.CWRTC"
00090  "BLDG1.T5" = "BLDG1.CWRTC" * "BLDG1.CWRTC" * "BLDG1.CWRTC" * "BLDG1.CWRTC" * "BLDG1.CWRTC"
00095  C Chilled water Density Calculation.  Note that the chilled water density calculation can be omitted with a less
       than 0.5% sacrifice in accuracy when using a constant, which is calculated based on the average return
       temperature
00100  "BLDG1.CHWDENSITY" = (999.8395 + 0.06798 * "BLDG1.CWRTC" - 0.00911 * "BLDG1.T2" + 0.0001 * "BLDG1.T3" - 1.127e-06
       * "BLDG1.T4" + 6.592e-09 * "BLDG1.T5") / 16.01846
00105  C Thermal Consumption Calculation
00110  $LOC1 = "BLDG1.CHWGPM" * "BLDG1.CWDT" * "BLDG1.CHWDENSITY"
00120  $LOC2 = $LOC1 * 1.0005 * 60 / 7.4805
00130  "BLDG1.CMMBTU" = $LOC2 / 1000 / 1000
00140  GOTO 10
```

Note: Chilled water density in this program is calculated based on chilled water return temperature and the assumption that the flow meter is installed on the chilled water return pipe. If the flow meter in your building is installed on the chilled water supply pipe, substitute "BLDG1.CWRT" with "BLDG1.CWST" on line 00050.

California Energy Commission
Public Interest Energy Research Program

HPCBS #
E5P2.2T2a3

HPCBS

High Performance Commercial Building Systems

Data Logging Guide for TAC Americas Energy Management and Control Systems

Element 5 - Integrated Commissioning and Diagnostics
Project 2.2 - Monitoring and Commissioning of Existing Buildings
Task 2.3.1 - Develop a guide to implementation of monitoring systems in existing buildings

Charles Culp
Energy Systems Laboratory, Texas A&M University
January 2003

California Energy Commission

Data Logging Guide

for

TAC – Americas

Energy Management and

Control Systems

Submitted By

Energy Systems Laboratory

Texas A&M University System

Acknowledgments

This work was completed under contract to Lawrence Berkeley National Laboratory as part of the High Performance Commercial Building Systems program. This program is supported by the California Energy Commission's Public Interest Energy Research (PIER) Buildings Program and the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technology, Building Technologies Program, of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

Numerous individuals contributed to completing the Data Logging Guide. TAC-Americas Corporation assigned key engineers to this effort. Yasuko Sakurai was the lead engineer from the Energy Systems Laboratory on this effort. She spent several months researching the engineering details to make this Guide. Lindsey Turns and Lindsay Patton also spent considerable time in reviewing and editing this work. The project lead was Charles H. Culp, P. E., Ph.D., Associate Director of the Energy Systems Laboratory and Visiting Professor at Texas A&M University.

The authors also thank TAC-Americas for their supporting data and collaboration during this study. Ken Broach, the lead TAC Engineer on this effort, spent numerous hours compiling the information and also reviewing the Guide for accuracy.

Table of Contents

EXECUTIVE SUMMARY

This Guide presents detailed procedures to determine the monitoring capability of an existing EMCS (Energy Management Control System) and perform any upgrades to the EMCS to enable data logging. This Guide outlines application procedures to enable an existing EMCS to measure the hourly energy consumption of a building or facility. The parameters to monitor include electrical consumption, thermal consumption (flow and temperatures), room temperature and other physical parameters.

This Guide enables the user to understand and verify how the existing controller can be configured to monitor the above parameters. Briefly, this includes:

- Determining the functionality of the existing EMCS controller models and software versions.
- Upgrading the physical monitoring capability of the existing controller, if needed.
- Selecting the correct sensors for the application in existing EMCS controllers.
- Following procedures to set up and configure the EMCS to log the desired data.

Once these procedures are fully implemented, the existing EMCS can be effectively used as a data logger. This results in a very cost effective method to acquire data logger quality data in an existing EMCS.

Chapter 1. Introduction

This Guide covers products designed by TAC-Americas (previously CSI, Control Systems International), introduced since 1994. A complete list of TAC-Americas software and hardware products that have been installed since 1994 are covered in this Guide. Improvements and introduction dates to the products are also covered. This Guide presents detailed procedures to determine the monitoring capability of a TAC-Americas existing EMCS (Energy Management Control System) and perform any needed upgrades to the EMCS to enable data logging.

Chapter 2 covers how to determine the functionality of the existing EMCS controller and software versions. Also covered is how to determine if upgrades are needed to the existing system. After implementing the steps in Chapter 2, the base system will be ready to be configured and used as a data logger.

Chapter 3 then covers specifically how to set-up and configure the EMCS as a data logger. Procedures are provided to enable selected data logger monitoring functions. These include electrical consumption, thermal flow and room monitoring. Data collection and storage requirements are also provided.

The Appendices covers programming details and accuracy determinations. A specific electrical consumption accumulation program, a thermal consumption calculation program and an extended log archiving program are provided. An example of temperature accuracy is provided so that the user can better determine the accuracy of thermal measurements.

This Guide enables the user to understand and verify that the existing controller can be configured to monitor the above parameters. Briefly, this includes:

- Determining the existing EMCS controller models and software versions.
    - Table 1 in Chapter 2 lists TAC-Americas' controllers and software versions. If the existing controller models and software versions found in the facility are listed in Table 1, this Guide can be used to upgrade the EMCS to store historical data of the parameters needed to determine the hourly energy consumption in a facility.

- Upgrading the physical monitoring capability of the existing controller, if needed.
    - Chapter 2 contains guidance on what will need to be upgraded, based on the existing EMCS models and software.
- Selecting the correct sensors for the application in existing EMCS controllers.
    - Chapter 3 provides information about what input types different controllers can accept and provides accuracy of the sensors. Guidance in selecting the correct sensor type is provided.
- Following procedures to set up and configure the EMCS to log the desired data.
    - Chapter 3 provides procedures to configure the EMCS to log data for specific applications. The applications include electrical consumption and demand monitoring using a Watt-Hour transducer, electrical consumption and demand monitoring using a Watt transducer, thermal monitoring using a Btu meter or EMCS, monitoring room temperature and data collection and storage guidance.

CHAPTER 2. DETERMINE EXISTING SYSTEM FUNCTIONALITY

STEP 1: Check the software version and the existing controller model of the controller connected to the sensor that will be used.

STEP 2: Verify the firmware release and hardware/software compatibility.

STEP 3: Find the general specification of the controller and the input type for each controller.

STEP 4: Check data logging performance of controller.

STEP 5: Upgrade EMCS for data logging.

Details of each step follow.

Step 1: Check the software version and the existing controller model of the controller connected to the sensor that will be used.

If the controller model is listed in Table 1, this Guide can provide a guideline of how to setup and store the history data. If the existing controller model is not included, consult with TAC-Americas to possibly use the existing controller or upgrade it to a current model. If I/NET 7700 is still used, a software upgrade to I/NET 2000 is recommended to eliminate any Y2K problems.

Table 1. TAC-Americas Hardware and Software Products

Hardware	
Name	Model Number
Distributed Control Unit	7700 DCU
	7740 DCU
Process Control Unit	7716 PCU
	7718 PCU
	7756 PCU
I/SITE I/O	7728 I/SITE I/O
Unitary Controller	7251 UC
	7270 UC
Micro Regulators	MR 123
	MR 55
	MR 88
	MR 632
	MR 160
	MR 88R
Software	
I/NET 2000	
I/NET 7700	

I/NET systems have the 7700 family of controllers (called DCU: Distributed Control Unit) as monitor and control instruments. Various sensors, actuators, transducers, signal converters and relay boards can be connected to these controllers to measure thermal and electrical properties and control HVAC equipment and lighting. All DCUs / controllers are located on the Controller LANs or the Controller subLANs. Several DCUs / controllers can operate on a single Controller LAN and share the sensor data, the internal calculations, and other information from one DCU / controller with other controllers. There are many different types of controllers under the 7700 family listed in Table 1 that can be configured with a variety of input and output (I/O) types.

- <u>7700 Distributed Control Unit (7700 DCU)</u>: This is the controller used in most I/NET systems. It communicates on the Controller LAN and provides automatic control and information about building operation.
- <u>7740 Distributed Control Unit (7740 DCU)</u>: This controller provides the same function and the basic I/O point capabilities as the 7700 DCU controllers. This controller does not allow any point expansion.
- <u>7716 Process Control Unit (7716 PCU)</u>: The 7716 provides the same functional capabilities as the 7700 controllers with reduced I/O point count and cost. It communicates on the Controller LAN and has the ability to connect directly to a host workstation without using a Tap. The expansion card, which adds input and output points, can extend the 7716 PCU controller I/O capabilities.
- <u>7718 Process Control Unit (7718 PCU)</u>: This controller is primarily designed for European distribution but sold in all markets. It contains similar functions as 7716 PCU controllers.
- <u>7756 Process Control Unit (7756 PCU)</u>: The 7756 PCU controller is a combination of a high-speed, fully distributed microprocessor-based motherboard (with 8 universal input points) and a high-resolution I/O board (with 24 universal input points).
- <u>7728 I/SITE I/O</u>: The 7728 controller is a satellite controller with a built-in display screen to support local operation without a local workstation. It contains similar functions as 7716 and 7718 controllers.
- <u>Unitary Controllers</u>: These controllers communicate on a Controller sub LAN and have a 7760 Unitary Controller interface as a gateway to communicate to the Controller LAN. There are several models of Unitary Controllers, 7210/7211, 7251, 7260 and 7270; however, the only two models recommended for monitoring are the 7251 UC and the 7270 UC.

- <u>Micro Regulators</u>: These controllers communicate on a Controller sub LAN and have a 7792 Micro Regulator Interface as a gateway to communicate to the Controller LAN. There are many models of Micro Regulator Controllers, MR 55, MR123, MR88, MR632, MR 160 and MR88R.

I/NET has two versions of software, I/NET 7700 and I/NET 2000. I/NET 7700 is the earlier EMCS software. It runs in a DOS environment and controls and monitors HVAC, lighting and other environmental systems. This software also allows the operator collect operating or environmental data, generate reports and include a graphic package that can provide a dynamic, animated display in color. For monitoring purposes, the I/NET 7700 feature of interest is Docutrend. Docutrend is a multi-purpose data collection and custom reporting utility that will be used extensively for monitoring purposes. The procedure of how to set-up Docutrend to collect and store data will be shown later in this Guide (see Chapter 3, Application F). I/NET 2000 is the upgraded version of I/NET 7700 that is running on Windows 95, 98 and NT 4.0. Most features, especially Docutrend, still work the same way. For more information, please contact TAC-Americas representatives.

Step 2: Verify the firmware release and hardware/software compatibility.

Knowing the year of EMCS installation, the firmware release and hardware/software compatibility can be found in Table 2. This table provides a revision time frame of each product launched since 1994. The first two columns from the time column are software revision time frames. The remaining columns are the hardware time frames, as listed in Table 1. In each column, the double line represents the starting time of the product (beginning with January 1994) and the single line represents the starting time of the new revision of that product. This table also shows the compatibility between hardware and software by using colors as follows.

Represents I/NET 7700 and its compatible system

Represents I/NET 2000 and its compatible system

Represents I/NET 7700 and I/NET 2000 Software compatible

Represents the starting year of system which is compatible to both I/NET 7700 and I/NET 2000 Software

Table 2. TAC-Americas Product Revision History

	INET7700	INET2000	7200 UC	7700 DCU	7756 PCU (Async)	7756 PCU (Sync)	7716 PCU (Async)	7716 PCU (Sync)	7718 PCU (Async)	7718 PCU (Sync)	7728 I/SITE I/O (Async)	7728 I/SITE I/O (Sync)	7740 DCU	MR123-032MB/632	MR123-210/430/400MB	MR160	MR55X	MR88
1/94	3.06		3.07	3.03				3.04		2.04			3.03	1.02	1.03			
2/94			3.08															
3/94	3.07			3.04				3.05		2.05			3.04	1.03	1.04			
4/94																		
5/94																		
6/94																		
7/94	3.10		3.09	3.10				3.10		2.10		1.00	3.10		1.10	1.00	1.00	
8/94	3.11											1.01		1.10	1.11	1.01		1.00
9/94	3.12														1.12			
10/94				3.11				3.11		2.11			3.11					
11/94	3.13																	
12/94																		
1/95																		
2/95						1.00		3.12						1.11				
3/95										2.12		1.02				1.02	1.01	1.01
4/95																		
5/95																		
6/95																		
7/95																		
8/95																		
9/95	3.14			3.12		1.01								1.12	1.13	1.03	1.02	1.02
10/95						1.02												
11/95																		
12/95	3.15							3.13		2.13		1.03	3.12					
1/96																		
2/96																		
3/96	3.16																	
4/96	4.00																	
5/96	4.01																	
6/96																		
7/96	4.02																	
8/96																		
9/96	4.03			3.13				3.14		2.14				1.13	1.14		1.03	1.03
10/96						1.03						1.04	3.13			1.04		
11/96																		
12/96	4.10																	
1/97																		
2/97																		
3/97																		
4/97																		
5/97	4.20																	
6/97																		
7/97						1.04		3.15		2.15			3.14					
8/97	4.21																	
9/97												1.05						
10/97																		

Table 2. TAC-Americas Product Revision History (continued)

	INET7700	INET2000	7200 UC	7700 DCU	7756 PCU (Async)	7756 PCU (Sync)	7716 PCU (Async)	7716 PCU (Sync)	7718 PCU (Async)	7718 PCU (Sync)	7728 I/SITE I/O (Async)	7728 I/SITE I/O (Sync)	7740 DCU	MR123-032MB/632	MR123-210/430/400MB	MR160	MR55X	MR88
11/97																		
12/97																		
1/98																		
2/98																		
3/98	4.30																	
4/98																		
5/98						1.05												
6/98				3.20									3.20					
7/98																		
8/98																		
9/98																		
10/98																		
11/98																		
12/98		1.00																
1/99		1.01																
2/99		1.10												1.13				
3/99		1.10a						3.20		2.20		1.10				1.04	1.03	
4/99	4.31																	
5/99		1.11																
6/99																		
7/99																		
8/99																		
9/99			3.09		2.00	1.10	4.00		3.00		2.00				1.14			1.03
10/99				3.21									3.21					
11/99		1.12																
12/99																		
1/00																		
2/00																		
3/00																		
4/00																		
5/00		1.13																
6/00																		
7/00																		
8/00		2.00																
9/00																		
10/00		2.10																
11/00									3.01	2.21			3.22					
12/00					2.10	1.20	4.01	3.21			2.10	1.20						
1/01				3.30										1.14		1.05	1.04	
2/01		2.11																
3/01																		
4/01									3.10	2.30								
5/01		2.12											3.30					
6/01		2.20			2.11	1.21	4.11	3.31	3.11	2.31	2.11	1.21						
8/01		2.21																

Step 3: Use Table 3 to find the general specification of the controller and the input type for each controller.

The four input types included for analog inputs are current, voltage, thermistor and platinum RTD. The digital input type requires the input to have a counter or accumulative feature. For example, if the 7700 DCU is going to be used to monitor room temperature, we can conclude from Table 3 that only a current or voltage-type temperature sensor can be used with this controller. This will help with selecting the correct sensor.

Table 3. TAC-Americas Hardware Specification

Model	Analog Input				Digital Input	
	Current	Voltage	Thermistor	Platinum RTD	Digital	Counter
7200 UC	N/A	N/A	N/A	N/A	contact closure	N/A
7700 DCU	4-20 mA ACCURACY 0.5 %	1-5 V DC ACCURACY 0.1 %	N/A	N/A	Optically isolated voltage input FREQ.: 4 Hz (max) PULSE WIDTH: 50 ms (min)	
7716 PCU	0-20 mA ACCURACY 0.5 %	0-5V, 0-10V ACCURACY 0.1 %, 2 %	N/A	N/A	5V @ 5 mA FREQ.: 4 Hz (max) PULSE WIDTH: 120 ms (min)	
7718 PCU	0-20 mA ACCURACY 0.5 %	0-5V, 0-10V ACCURACY 0.1 %, 2 %	N/A	N/A	5V @ 5 mA FREQ.: 4 Hz / 20 Hz PULSE WIDTH: 120 ms (min)	
7728 I/SITE I/O	0-20 mA ACCURACY 0.5 %	0-5V, 0-10V ACCURACY 0.1 %, 2 %	10K Ω ACCURACY 5 % [Typ. 2 %]	N/A	5V @ 5 mA FREQ.: 4 Hz / 20 Hz PULSE WIDTH: 55 ms (min)	
7740 DCU	0-20 mA ACCURACY 0.5 %	0-5 V ACCURACY 0.1 %	N/A	N/A	Dry contact FREQ.: 4 Hz (max) PULSE WIDTH: 120 ms (min)	

Table 3. TAC-Americas Hardware Specification (continued)

Model	Analog Input				Digital Input	
	Current	Voltage	Thermistor	Platinum RTD	Digital	Counter
7756 PCU Upper motherboard Lower motherboard	 0-20 mA ACCURACY 0.4% 0-40 mA ACCURACY 0.12%	 0-5 V ACCURACY 0.1% 0-10 V ACCURACY 0.02%	N/A	N/A	 5V @ 5 mA FREQ.: 4 Hz (max) PULSE WIDTH: 120 ms (min) 5V @ 5 mA FREQ.: 20 Hz (max) PULSE WIDTH: 25 ms (min)	
MR 55	N/A	N/A	10K Ω ACCURACY 2 %	N/A	5V @ 0.5 mA PULSE WIDTH: 1 ms (min)	
MR 123	N/A	0-10 V ACCURACY 2 %	10K Ω ACCURACY 2 %	N/A	5V @ 5 mA FREQ.: 9 Hz (max) PULSE WIDTH: 55 ms (min)	
MR 88 MR 88R MR 160 MR 632	0-20 mA ACCURACY 2 %	0-5V,0-10V ACCURACY 1%, 2%	10 K Ω ACCURACY 2 %	N/A	5V @ 5 mA FREQ.: 4 Hz (max) PULSE WIDTH: 100 ms (min)	

Step 4: Check data logging performance of controller.

Knowing the existing controller, use Table 4 to check for acceptable data logging performance of the controller for each monitoring parameter: electrical consumption, thermal consumption and room temperature. Table 4 provides recommendations in the event the existing controller cannot be used to monitor a parameter.

Table 4. TAC-Americas Hardware and Monitoring Capabilities Compatibility

	Electrical Consumption		**Thermal Consumption**		**Room Temperature**
Sensor Device Output	Digital	Analog	Digital	Analog	Analog
7200 UC	X^1	X^1	X^1	X^1	•
7700 DCU	•	•	•	•	•
7716 PCU	•	•	•	•	•
7718 PCU	•	•	•	•	•
7728 I/SITE I/O	•	•	•	•	•
7740 DCU	•	•	•	•	•
7756 PCU	•	•	•	•	•
MR 55	X^2	X^2	X^2	X^1	•
MR 123	•	X^2	•	X^1	•
MR 88, 88R, 160, 632	•	•	•	X^1	•

- Indicates acceptable performance for logging a point type:

X^1 Replace this device with a PCU 7716

X^2 Replace this device with a MR88

Note that the 7200 UC (Unitary Controller) only accepts a special temperature sensor type. Therefore, it cannot be used to monitor other parameters. The MR 55 (Micro Regulator) cannot be used for BTU calculation because of the input slot limitation and low accuracy.

Step 5: Upgrade EMCS for data logging

After establishing the compatibility and type of parameter to be monitored and logged, and knowing which type of meter or calculation to use, a set of upgrade procedures can be selected. The following application upgrade procedures are outlined in Chapter 3:

- Electrical Consumption and Demand Monitoring Using Watt Hour Transducer (digital input)
- Electrical Consumption and Demand Monitoring Using Watt Transducer (analog input)
- Thermal Consumption Monitoring Using BTU Meter
- Thermal Consumption Monitoring Using EMCS
- Room Temperature Monitoring

Chapter 3. Application Set-up Procedures

The following tables provide the requirements to enable the existing controllers to perform the specified functions.

Application A. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer.

Application B. Electrical Consumption Monitoring Using A Watt Transducer.

Application C. Thermal Consumption Monitoring Using BTU Meter.

Application D. Thermal Consumption Monitoring Using EMCS.

Application E. Room Temperature Monitoring.

Application F. Configure For Data Collection And Storage In I/NET 2000.

Application A. Electrical Consumption and Demand Monitoring Using a Watt Hour Transducer

Charts A-1 through A-4 will provide the user with steps to set up a Watt Hour Transducer to monitor electrical consumption and demand. By following these steps, the user will enable the EMCS to measure electrical consumption (kWh) and store fifteen-minute data. Chart A-1 lists the needed equipment and helps the user determine whether the controller has an available input slot. Chart A-2 aides the user in choosing a Watt Hour Transducer (WHT) and a Current Transducer (CT). The chart lists the accuracy, pulse widths and pulse rates the WHT and CT require for each controller model. The chart also lists wire and sensor specifications. Tips for CT installation are provided as well. Chart A-3 provides an example of a WHT and a CT available in the market. Chart A-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly consumption, display current demand and record 15-minute demand. The user should then proceed to Application F to set up the data collection and history data storage.

STEP 1. Check the input slot availability on the controller.

> Use Chart A-1 to find which slots are needed on the controller. The position of the slot can be found in Chart A-1 under Controller Terminal Connections. For example, the 7756 PCU needs an available slot on one of its six terminal blocks,TB1-x, TB1A-x, TB1B-x, TB2-x, TB2A-x or TB2B-x. The lower case "x" represents the terminal position in that terminal block and is denoted by 1, 4, 7 or 10. If slots are available on any of these, the procedure can be followed. If there are no available slots please contact a TAC-Americas representative to determine whether an expansion I/O module can be added to this controller or if an additional controller should be installed.

STEP 2. Choose a Watt Hour Transducer (WHT) and Current Transducer (CT).

Chart A-2 lists the WHT and CT specifications. For example, an acceptable Watt Hour Transducer for 7756 PCU should have discrete output with ± 0.5% accuracy or better and at least 120 ms pulse width at 4 Hz maximum pulse rate (for the upper mother board input) or at least 25 ms pulse width at 20 Hz maximum pulse rate (for the lower I/O board). With matching CT output and accuracy selection of 1% or better, the end-to-end accuracy from the transducers to the 7756 PCU controller could be around ± 1.5%. Note that to gain this accuracy the transducers must be placed no further than 200 ft. away with 22 AWG type wire.

Chart A-3 shows an example of a WHT and a CT provided in the market.

STEP 3. Follow the EMCS programming steps.

Chart A-4 provides the steps to set up the external input point from the transducer and the internal points to store the consumption value the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point and internal points.

STEP 4. Follow the steps in Application F.

Application F lists the steps to set up the data collection and history data storage.
After following the above steps, the system can collect monthly consumption, display current demand, and record 15-minute demand.

Chart A-1. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

Verify that in addition to the sensors and transducer, the controller has the available slots as discussed below. In addition, the terminal connections on the controller need to have the resistors connected as specified below.

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
What is measured	• Electrical consumption of either One-Phase or Three Phase, 208 to 480 V ac rms, 50/60 Hz							
What is stored in EMCS	• Fifteen-minute data of electric consumption in kWh units stored in Trend Data History.							
What is needed	3 - CT sensor 1 - Watt Hour Transducer 1 – available slot on Terminal Block (for external discrete input) 2 – available internal points 1 – available internal analog output point (to display current demand) 1 – available internal pulse input point (to accumulate month-to-date consumption)							
Controller Terminal Connections	TB1-x, TB1A-x, TB1B-x, TB2-x, TB2A-x or TB2B-x where x can be 1,4, 7 or 10	TB3 – x where x is 1-8	TB1 or TB2	TB1 or TB2	TB1, TB2 or TB3	TB5 – x where x is 1, 3, 5, …, 15	TB4 – x where x is 3-5	TB5 or TB6 for MR 160 TB4 for others
Resistor in Terminal Connections	A 1KΩ, 1/8 W, 1% resistor in "B" position (and "D" position for 20 Hz)	None	A 1KΩ, ¼ W, 5% resistor in "B" position	A 1KΩ, ¼ W, 5% resistor in "B" position	A 1KΩ, ¼ W, 5% resistor in "B" position	None	None	A 1KΩ, 1/8 W, 1% resistor in "B" position

Chart A-2. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

Watt Hour Transducer and Current Transducer Specifications

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
Output Type from Watt Hour Transducer	Discrete (each pulse is equal to xxx kWh, varies with specific sensor)							
Maximum Pulse Rate	4 Hz for upper motherboard/ 20 Hz for lower I/O board	4 Hz	4 Hz	4 / 20 Hz	4 / 20 Hz	4 Hz	9 Hz	4 Hz
Minimum Pulse Width	120 ms for upper motherboard / 25 ms for lower I/O board	50 ms	120 ms	120 ms	55 ms	120 ms	55 ms	100 ms
Accuracy from Watt Hour Transducer	±0.5 % (not including CT's)							
Maximum Wire Length (ft.)	200 ft. @ 22 AWG (guideline from manufacturer)							
CT Accuracy	± 1.0 %							
Note	CT sensors Output: Match the input type for Watt Hour Transducer Input: Make sure that input current is enough to cover the normal current							
End-to-end Accuracy	± 1.5 %							

Next, the specifications for the Watt Hour Transducer must satisfy the input requirements for the controller.

Make sure that the device will cover the peak demand kW, not generate more pulses than the maximum pulse rate and maintain the signal pulse width at least for the minimum pulse width duration. Current Transformers (CT's) have several styles. Split core CTs are easier to install. Make sure that these are installed in the correct direction. Checking the polarity of the current read by the EMCS can do this.

Notes on installation:

- Install CT sensors on the electrical main panel. Follow the manufacturer's instructions.
- Install Watt Hour Transducer and terminate CT sensor outputs at the WHT inputs. Follow the manufacturer's instructions.
- Electrical shock can occur from CT's without a shunt resistor.
- Terminate Watt Hour Transducer output at the Terminal Block. Follow the manufacturer's instructions.

Chart A-3. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

An Example of Watt Hour Transducer Specifications

The following Watt-Hour Transducer has been successfully used.

Watt Hour Transducer		
Ohio Semitronics, Inc.		
WL-3968		
Input	Current	Output from Current Transformer 0 - 0.333 V
	Voltage	120/208 & 277/480
	Phase	Three-Phase, Three-Wire or Three-Phase, Four-Wire
	Range	±15%
	Burden	None
	Power Factor	0.5 Lead to 0.5 Lag
	Instrument Power	208/240/480, 50/60 Hz, 2.5 Watts
Output	Relay	Dry Contact, 120 V, 0.3 A, 10 VA Max
	Closure Duration	250 Milliseconds
	Accuracy	± 0.5% F.S.
	Isolation	Input/Output/Case 750 Vac
	Temperature Effects	(-20°C to +60°C) +/- 0.02%/°C

Chart A-3. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer (continued)

An Example of Current Transducer Specifications

The following Current Transducer has been successfully used.

Current Transducer		
Sentran Corporation		
4LS3 Split Bus Bar		
Input	Current	AC current, sinewave, single phase 60 Hz, Load PF 0.5-1 lead or lag 100, 200, 300, 400, 500, 600, 800, 1K, 1.5K, 2K, 2.5K and 3K Amp
	Voltage rating	600 V ac Tested Per ANSI C57.13 BIL 10 KV AC Full Wave for 60 seconds
	Bandwidth	10 Hz to 1000 Hz +/- 3 db
Output	Voltage	100 mV, 250 mV, 333 mV, 500 mV, 1 V and 5 V
	Limiting	20 V AC RMS
	Accuracy	± 1% ratio and linearity accuracy from 5% to 200% of scale
	Phase Displacement	± 1 degree
	Output Resistance	< 100 Ohms
	Interface Resistance	> 10K Ohms
	Lead Wires	20 or 22 AWG UL1015, 600V insulation, 105 C

Chart A-4. Electrical Consumption And Demand Monitoring Using A Watt-Hour Transducer

EMCS Programming Steps

Summary

1. Set up an external pulse input (PI) point in EMCS to accumulate daily consumption for the Wh-to-pulse transducer.
2. Set up an internal pulse input (PI) point to accumulate monthly consumption from the external point created in Step 1.
3. Set up an internal analog output (AO) point in EMCS to display current demand from the external point created in Step 1.
4. Create a Demand Control point extension on external PI point created in Step 1.
5. Create a Trend point extension on the internal analog output point in EMCS allowing the EMCS to record demand values every fifteen minutes.

<u>Step 1</u>. Set up an external pulse input (PI) point in EMCS to accumulate daily consumption for Wh-to-pulse transducer.

In I/NET 2000, perform the following steps:

a. Connect installed sensors to the controller.

b. Select “Edit”, then “Controller”, then “Resident I/O Points”.

c. Click “Add” and New Resident Point editor will be displayed. Set the following parameters as specified below:

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R,160, 632
Input Type	PI							
Input Address	See Appendix A	280x x is pin # -1 Ex: TB3-1 has the address of 2800 Point: 28 Bit Offset: 00	0000-0007	0000-0007	0000-0007 and 0100-0103	280x x is (pin #-1)/2 Ex: TB5-11 has the address of 2805 Point: 28 Bit Offset:05	02-04	00-06 except for MR632 00-04
	Click “OK”							
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 kWh							
Scan Interval	1 second							
Point Class	External							
Global Level	Local (for not sharing the point information with other controllers)							
Alarm Priority	None							
Message Priority	None							
Engineering Unit	Select a number that corresponds to the line number of “kWh”in Engineering Units Table							

Conversion Coefficient	Select a number that corresponds to the line number of "slope (m) = xxx and offset (b) = 0" in Conversion Coefficients Tables. If the correct slope and offset are not available, choose an empty pair (m=0, b=0) and enter the correct slope in the conversion coefficient editor (Edit -> Controller -> Station Parameters -> Conversion Coefficients)
Conversion Equation	Linear
Scan Between Broadcast	60 (broadcast value of this accumulator every 1 minute)
Accumulator Type	External 8 bit
	Click "OK"

Step 2. Set up an internal pulse input (PI) point to accumulate monthly consumption from the external point created in Step 1.

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Resident I/O Points".
b. Click "Add" and then New Resident Point editor will be displayed. Set the following parameters as specified below:

Input Type	PI
Output Address	Choose an unreserved internal address (See Appendix A for the list of hardware point addresses to be avoided)
	Click "OK"
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 Monthly kWh
Scan Interval	10 seconds
Point Class	Internal
Global Level	Local (for not sharing the point information with other controllers)

Alarm Priority	None
Message Priority	None
Engineering Unit	Select a number that corresponds to the line number of "kWh"in Engineering Units Table
Conversion Coefficient	Select a number that corresponds to the line number of "slope (m) = 1 and offset (b) = 0" in Conversion Coefficients Tables. If the correct slope and offset are not available, choose an empty pair (m=0, b=0) and enter the correct slope in the conversion coefficient editor (Edit -> Controller -> Station Parameters -> Conversion Coefficients)
Conversion Equation	Linear
Accumulator Type	Reflective
Scans Between Broadcasts	1
	Click "OK"

Step 3. Set up an internal analog output (AO) point in EMCS to display current demand from the external point created in Step 1.

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Resident I/O Points".

b. Click "Add", and New Resident Point editor will be displayed. Set the following parameters as specified below:

Input Type	AO
Output Address	Choose an unreserved internal address (See Appendix A for the list of hardware point addresses to be avoided)
	Click "OK"
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 Current kW
Scan Interval	60 seconds
Point Class	Internal
Global Level	Local (for not sharing the point information with other controllers)

Alarm Priority	None
Message Priority	None
Engineering Unit	Select a number that corresponds to the line number of “kW”in Engineering Units Table
Conversion Coefficient	Select a number that corresponds to the line number of “slope (m) = 0.1 and offset (b) = 0” in Conversion Coefficients Tables. If the correct slope and offset are not available, choose an empty pair (m=0, b=0) and enter the correct slope in the conversion coefficient editor (Edit -> Controller -> Station Parameters -> Conversion Coefficients)
Offset	0
Low Output Limit	0
High Output Limit	6553.5
Broadcast Change Counts	1
	Click “OK”

Step 4. Create a Demand Control point extension on external PI point created in Step 1.

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Controller”, then “Resident I/O Points”.
b. Click the “DC” box at the top of the window.
c. Locate the external PI point collecting pulses from the Wh-to-pulse transducer (BLDG1 kWh in this example) and click on the point address.
d. Click “Add” and Demand Control Extension Editor will be displayed. Set the following parameters as specified below.

Demand Interval	Determined by utility rate tariff, usually 15 minutes

Current Demand Point	Select name of internal AO point from pull-down (BLDG1 Current kW in this example)
Monthly Consumption Point	Select name of internal PI point from pull-down (BLDG1 Monthly kW in this example)
	Leave all other items at their default value and click "OK."

Step 5. Create a Trend point extension on the internal analog output point in EMCS. This will allow the EMCS to record demand values every fifteen minutes.

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Resident I/O Points".
b. Click the "TR" box at the top of the window.
c. Locate the internal AO point displaying the current demand (BLDG1 Current kW in this example) and click on the point address.
d. Click "Add" and Trend Extension Editor will be displayed. Set the following parameters as specified below:

Sample Control Interval	15 minutes
Number of samples	1440 (will keep a fifteen-day rolling history of 15-minute demand readings in controller)
Sample control mode	None
	Leave all other items at their default value and click "OK."

Application B. Electrical Consumption Monitoring Using A Watt Transducer

Charts B-1 through B-4 provide the user with steps to set up a Watt Transducer to monitor electrical consumption and demand. By following these steps, the user will enable the EMCS to measure electrical consumption (kWh) and store fifteen-minute data. Chart B-1 lists the needed equipment and helps the user determine whether the controller has an available input slot. Chart B-2 aids the user in choosing a Watt Transducer (WT) and a Current Transducer (CT). The table lists the accuracy, output type and maximum length of wire the WT and CT require for the controller models. Chart B-3 provides an example of a WT and a CT available in the market. Chart B-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly consumption, display current demand and record 15-minute consumption. The user should then proceed to Application F to set up the data collection and history data storage.

STEP 1. Check the input slot availability on the controller.

Use Chart B-1 to find which slots are needed on the controller. The position of the slot can be found in Chart B-1 under Controller Terminal Connections. For example, 7700 DCU needs an available slot either on TB4-x or TB5-x. The lower case “x” represents the terminal positions, TB4 or TB5 terminal block, where “x” can be 1 to 8. If slots are available on either of these, the procedure can be followed. If there are no available slots please contact a TAC-Americas representative to check whether an expansion I/O module can be added to this controller or if an additional controller needs to be installed.

STEP 2. Choose a Watt Transducer (WT) and Current Transducer (CT).

> Chart B-2 lists the WT and CT specifications. For example, an acceptable Watt Transducer for 7700 DCU should have analog output (preferred current 4-20 mA) with 0.5% accuracy or better. With matching CT output and accuracy selection of 1% or better, the end-to-end accuracy from the transducers to the 7700 controller could be around 2%. Note that to gain this accuracy the transducers must be placed no further than 200 ft. away with 22 AWG wire type. Chart B-3 shows an example of WT provided in the market. CT is included in this Watt Transducer example.

STEP 3. Follow the EMCS programming steps.

Chart B-4 provides the steps to set-up the external input point from the transducer and the internal points to store the consumption value the EMCS must recognize. Detailed steps provided in this chart must be followed to setup the external input point and internal points.

STEP 4. Follow the steps in Application F.

Application F lists the steps to set up the data collection and history data storage.
After the steps are complete, the system can be used to record monthly consumption and display current demand.

Chart B-1. Electrical Consumption Monitoring Using Watt Transducer

Verify that in addition to the sensors and transducer, the controller has the available slots as discussed below. In addition, the terminal connections on the controller need to have the resistors connected as specified below.

<table>
<tr><th></th><th>7756 PCU</th><th>7700 DCU</th><th>7716 PCU</th><th>7718 PCU</th><th>7728 I/SITE I/O</th><th>7740 DCU</th><th>MR 123</th><th>MR 88, 88R, 160, 632</th></tr>
<tr><td>What is measured</td><td colspan="8">Electrical consumption of either One-Phase or Three Phase, 208 to 480 V ac rms, 50/60 Hz</td></tr>
<tr><td>What is stored in EMCS</td><td colspan="8">Fifteen-minute data of electric consumption in kWh unit stored in Trend Data History.</td></tr>
<tr><td>What is needed</td><td colspan="8">3 - CT sensor
1 - Watt Transducer
1 – available slot on Terminal Block (for analog input)
1 – available internal accumulative points for electrical consumption</td></tr>
<tr><td>Controller Terminal Connections</td><td>TB1-x, TB1A-x, TB1B-x, TB2-x, TB2A-x or TB2B-x where x can be 1,4, 7 or 10</td><td>TB4–x or TB5-x where x is 1-8</td><td>TB1 or TB2</td><td>TB1 or TB2</td><td>TB1, TB2 or TB3</td><td>TB6-x or TB7-x where x is 1, 3, 5, …, 15</td><td rowspan="2">Not Recommended Use MR88</td><td>TB4</td></tr>
<tr><td>Resistor in Terminal Connections</td><td>A 249Ω, 1/8W, 0.1% resistor in “A” position*</td><td>None</td><td>A 249Ω, 1/8 W, 0.1% resistor in “A” position</td><td>A 249Ω, 1/8 W, 0.1% resistor in “A” position</td><td>A 249Ω, 1/8 W, 0.1% resistor in “A” position</td><td>None</td><td>A 249Ω, 1/8 W, 0.1% resistor in “A” position</td></tr>
</table>

Chart B-2. Electrical Consumption Monitoring Using Watt Transducer

Watt Transducer and Current Transducer Specifications

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
Output Type from Watt Transducer	Analog, 4-20 mA							
Accuracy from Watt Transducer	±0.5 % (not including CT's)							
Maximum Wire Length (ft.)	200 ft. @ 22 AWG (guideline from manufacturer)							
CT Accuracy	± 1.0 %							
Note	CT sensors • Output: Match the input type for Watt Transducer • Input: Make sure that input current is enough to cover the normal current							
End-to-end Accuracy	Upper MB: ± 1.9 % Lower MB: ± 1.7 %	±2.0 %	±2.0 %	±2.0 %	±2.0 %	±2.0 %	Not Recommended Use MR 88	±3.5 %

Next, the specifications for the Watt Transducer must satisfy the input requirements for the controller. Make sure that the device will cover the peak demand kW. An example of the available Watt Transducer is shown in the next chart. The Current Transducer is already included in this example.

Chart B-3. Electrical Consumption Monitoring Using Watt Transducer

Example of Watt Transducer Specifications

Watt Transducer (CT included)		
Veris Industries, Inc.		
H-8040		
Input	Primary Voltage	208 or 480 V ac rms
	Phase	One-Phase or Three-Phase
	Primary Current	Up to 2400 amps cont. per phase
Output	Type	4 – 20 mA
	Supply Power	9 – 30 V dc; 30 mA max
	Accuracy	± 1%
	Internal Isolation	2000 V ac rms
	Case Insulation	600 V ac rms
	Current Transformer	Split core, 100, 300, 400, 800, 1600 or 2400 amps

Chart B-4. Electrical Consumption Monitoring Using Watt Transducer

EMCS Programming Steps

Summary

1. Set up an external analog input (AI) point in EMCS to accumulate daily consumption for the kW-to-pulse transducer.
2. Set up an internal accumulator point in EMCS.
3. Create a Trend point extension on the internal analog output point in EMCS.

This application will allow the EMCS to record 15-minute demand values.

Step 1. Set up an external analog input (AI) point in EMCS to accumulate daily consumption for the kW-to-pulse transducer.

In I/NET 2000, perform the following steps:

a. Connect the installed sensors to the controller.

b. Select “Edit”, then “Controller”, then “Resident I/O Points”.

c. Click “Add”, and New Resident Point editor will be displayed. Set the following parameters as specified below:

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R,160, 632
Input Type	AI							
Input Address	See Appendix A	TB4-x: 0X00 X = x –1 TB5-y: YY00 YY = y + 7 Ex: TB5-1 has the address of 0800 Point: 08 Bit Offset 00	0000-0007	0000-0007	0000-0007 and 0100-0103	TB6-x: 0X00 X = (x –1)/2 TB7-y: YY00 YY = 8 + (y-1)/2 Ex: TB7-1 has the address of 0800 Point: 08 Bit Offset 00	Not Recommended Use MR 88	00-06 except for MR632 00-04
	Click “OK”							
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 kW							
Scan Interval	1 second							
Point Class	External							
Global Level	Local (for not sharing the point information with other controllers)							
Alarm Priority	None							
Message Priority	None							
Engineering Unit	Select a number that corresponds to the line number of “KW” in Engineering Units Table							
Conversion Equation	Linear							
A/D Converter	Upper MB 12 bit Lower MB 16 bit	12 bit + 1 sign bit	12 bit	12 bit	12 bit	12 bit	Not Recommended Use MR88	8 bit

Conversion Coefficient	Use Pop-up Calculator to calculate for slope and offset
Pop-up Calculator	• Equipment Count Low: 0 (typical) • Equipment Count High: depend on controller A/D converter, 255 for 8-bit, 4,095 for 12-bit and 65,535 for 16-bit • Engineering Unit Low: The units being measured for the sensor when the device is at its low count value • Engineering Unit High: The units being measured for the sensor when the device is at its high count value
Offset	0 (default) or actual error divide by "slope (m)"to calibrate sensor, compensate for the long wire runs
Low Sensor Limit	The lowest number showing sensor is not in error, this number is the lowest kW
High Sensor Limit	The highest number showing sensor is not in error, this number is the highest kW
Low Alarm Limit	The lowest number before this point goes into alarm, 0 kW
High Alarm Limit	The highest number before this point goes into alarm, at least equal to High Sensor Limit
Broadcast Change Counts	Round-up number of 1% full scale kW demand divide by slope (m) For example: highest demand is 2000 kW, Broadcast Change Counts = 0.01*2000/m
Non-linear Lookup Table	0 (no lookup table)
	Click "OK"

Step 2. Set up an internal accumulator point in EMCS.

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Resident I/O Points".

b. Click "Add", and New Resident Point editor will be displayed. Set the following parameters as specified below:

Input Type	PI
Input Address	See Appendix A on point address summary, avoid using those hardware point addresses
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 KWHr
Point Class	Internal
Scan Interval	1 second
Global Level	Local (for not sharing the point information with other controllers)
Alarm Priority	None
Message Priority	None
Engineering Unit	Select a number that corresponds to the line number of "KWh"in Engineering Units Table
Conversion Coefficient	Select a number that corresponds to the line number of "slope (m) = 1 and offset (b) = 0" in Conversion Coefficients Tables
Conversion Equation	Linear
Accumulator Type	Integrating
Scans Between Broadcast	60 (broadcast value of this accumulator every 1 minute)
	Click "OK"
In Resident I/O Point window	• Add calculation in to the above PI point • In Equation Field, put "P0" • In Points, put point address of the kW demand AI point above, then click "OK"

<u>Step 3</u>. Create a Trend point extension on an internal accumulative point in EMCS. This will allow the EMCS to record 15-minute consumption values.

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Resident I/O Points".
b. Click the "TR" box at the top of the window.
c. Locate the internal PI point displaying the current consumption (BLDG1 KWHr in this example) and click on the point address.
d. Click "Add", and Trend Extension Editor will be displayed. Set the following parameters as specified below:

Sample Control Interval	15 minutes
Number of samples	1440 (will keep a fifteen-day rolling history of 15-minute demand readings in controller)
Sample control mode	None
	Leave all other items at their default value and click "OK."

Application C. Thermal Consumption Monitoring Using BTU Meters

Charts C-1 through C-4 will provide the user with steps to set up a BTU meter to monitor thermal consumption. By following these steps, the user will enable the EMCS to measure thermal consumption (MMBtu) and store fifteen-minute data. Chart C-1 lists the needed equipment and helps the user determine whether the controller has an available input slot. Chart C-2 aids the user in choosing a BTU meter, temperature sensors and a flow meter. The chart lists the BTU meter, temperature sensor and flow meter accuracy for the controller models. The table also lists output type, pulse widths and pulse rates the BTU meter requires. Some tips for BTU meter selection and flow meter installation are provided as well. Chart C-3 provides an example of a BTU meter, a temperature sensor and a flow meter available in the market. Chart C-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly thermal consumption. The user should then proceed to Application F to set up the data collection and history data storage.

STEP 1. Check the input slot availability on the controller.

Use Chart C-1 to find which slots are needed on the controller. The position of the slot can be found in Chart C-1 under Controller Terminal Connections. For example, 7716 PCU requires an available slot on Terminal Block TB1 or TB2. If slots are available on either of these, the procedure can be followed. If there are no available slots please contact a TAC-Americas representative to determine whether an expansion I/O module can be added to this controller or if an additional controller should be installed.

STEP 2. Choose a BTU Meter, Temperature Sensor and Flow Meter.

Chart C-2 lists the BTU meter, temperature sensor and flow meter specifications. For example, an acceptable BTU meter for 7716 PCU should have discrete output with at least 120 ms pulse width at 4 Hz maximum pulse rate. This BTU meter should be installed with matching temperature sensors and flow meter output at the recommended accuracy. The end-to-end accuracy of this thermal measurement does not only depend on the meter and sensors, but also the characteristics of the system (differential temperature). Chart C-2 and

Appendix B provide more information on this. Chart C-3 shows examples of a BTU meter, temperature sensors and a flow meter provided in the market.

STEP 3. Follow the EMCS programming steps.

Chart C-4 provides the steps to set up the external input point (from the BTU Meter) the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point and internal points.

STEP 4. Follow the steps in Application F.

Application F lists the steps to set up the data collection and history data storage.

After these steps are complete, the system can collect and store monthly thermal consumption data.

Chart C-1. Thermal Consumption Monitoring Using A BTU Meter

Verify that in addition to the sensors and transducer, the controller has the available slots as discussed below. In addition, the terminal connections on the controller need to have the resistors connected as specified below.

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
What is measured	• Chilled/Hot water flow • Chilled/Hot water supply and return temperature							
What is stored in EMCS	• Fifteen-minute data of Thermal Consumption in MMBtu units stored in Trend Data History							
What is needed	1 – Flow meter 2 – Temperature sensors 1 – BTU meter 1 – available slot on Terminal Block (for digital input)							
Controller Terminal Connections	TB1-x, TB1A-x, TB1B-x, TB2-x, TB2A-x or TB2B-x where x can be 1,4, 7 or 10	TB3 – x where x is 1-8	TB1 or TB2	TB1 or TB2	TB1, TB2 or TB3	TB5 – x where x is 1, 3, 5, …, 15	TB4 – x where x is 3-5	TB5 or TB6 for MR 160 TB4 for others
Resistor in Terminal Connections	A 1KΩ, 1/8 W, 1% resistor in "B" position (and "D" position for 20 Hz)	None	A 1KΩ, ¼ W, 5% resistor in "B" position	A 1KΩ, ¼ W, 5% resistor in "B" position	A 1KΩ, ¼ W, 5% resistor in "B" position	None	None	A 1KΩ, 1/8 W, 1% resistor in "B" position

Chart C-2. Thermal Consumption Monitoring Using a BTU Meter

BTU Meter, Flow Meter and Temperature Sensor Specifications

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
Output Type from BTU Meter	Digital Pulse (each pulse is equal to xxx MMBtu, varies with specific meter)							
Maximum Pulse Rate	4 / 20 Hz	4 Hz	4 Hz	4 / 20 Hz	4 / 20 Hz	4 Hz	9 Hz	4 Hz
Minimum Pulse Width	120 / 25 ms	50 ms	120 ms	120 ms	55 ms	120 ms	55 ms	100 ms
Accuracy from Flow Meter	Recommended Accuracy for flow meter is ± 1% full scale							
Accuracy from Temperature Sensor	Recommended Accuracy: ± 0.2 °F for chilled water temperature sensors and ± 0.5 °F for hot water temperature sensors							
End-to-end Accuracy	Depends on the accuracy of the temperature sensor, flow meter and how large the temperature difference is. Assuming the difference between chilled water supply and return temperature is 10 °F, the end-to-end accuracy can approach 5%. Assuming the difference between hot water supply and return temperature is 20 °F, the accuracy can approach 7%, without end-to-end calibration. See Appendix B							

Tips on BTU Meter selection:

- Ensure the BTU meter will cover the peak BTU, will maintain the output pulse signal with at least the minimum pulse width and not generate pulses in excess of the maximum pulse rate.
- Use matched temperature sensors.
- Temperature sensor and flow meter outputs are correct for the BTU meter inputs.
- The specifications for the BTU meters must satisfy the input requirements for the controller.

Notes on installation:

- Install the flow meter in the supply or return pipe.
- Install matched temperature sensors, one on the supply pipe and another on the return pipe.
- For the temperature sensor on the same pipe as the flow meter, install the sensor close to the flow meter.
- Disconnect the flow meter and temperature sensors at the BTU meter input board. Follow the manufacturer's instructions.
- Disconnect the BTU meter output at the terminal block. Follow the manufacturer's instructions.

Chart C-3. Thermal Consumption Monitoring Using a BTU Meter

An Example of BTU Meter, Flow Meter and Temperature Sensor Specifications

The following BTU meter, flow meter and temperature sensors have been used successfully.

BTU Measurement System, Keegan Electronics, Inc., System 90 Series		
Input	Temperature	2 matched temperature sensors supplied by Keegan Electronics
	Minimum Resolution of Temperature Reading	0.1°C
	Flow	1 flow sensor supplied by Data Industrial
	Minimum Closure Duration	2 milliseconds
	Maximum Length of cable	500 feet
	Electrical	Connect to high voltage (120 V AC) through a circuit breaker
Output	Standard Output	Monostable relay outputs, SPST, 2A @ 120 V AC resistive representing BTU's and Gallons
	Optional Output	0-1 mA DC or 4-20 mA DC representing instantaneous BTU/Hr and GPM
	Accuracy	Depends on the accuracy of temperature sensor, flow meter and how large the temperature difference is.

Temperature Sensor, Keegan Electronics, Inc., RTDs for System 90 Series		
Input	Temperature Range	0-100 °C
Output	Standard Output	RTD – variable resistance
	Reference	@ 0°C – output is equal to 32,654 ohms @ 100°C – output is equal to 679 ohms
	Accuracy	± 0.2 °C

Chart C-3. Thermal Consumption Monitoring Using a BTU Meter

An Example of BTU Meter, Flow Meter and Temperature Sensor Specifications

Flow Sensor, Data Industrial, 220 PVCS Insert Flow Sensor		
Input	Flow Rate	1 to 30 ft./sec
	Maximum Pressure	100 psi @ 68°F
	Maximum Temperature	140°F @ 40 psi
	Maximum Length of cable	20 feet shielded twisted pair AWG 20
Output	Standard Output	Voltage pulse, 5V or greater
	Accuracy	± 1% of Full Scale (over recommended design flow range)
	Absolute Accuracy	± 4% of reading within calibration range
	Linearity	± 1%
	Frequency	3.2 – 200 Hz
	Pulse Width	5 milliseconds ± 25%

Chart C-4. Thermal Consumption Monitoring Using a BTU Meter

EMCS Programming Steps

Summary

1. Set up an external pulse input (PI) point in EMCS to accumulate daily consumption for the BTU Meter.
2. Set up an internal pulse input (PI) point to accumulate monthly consumption from the external point created in Step 1.
3. Create a Trend point extension on the internal pulse input point in EMCS. This will allow the EMCS to record 15-minute consumption values.

The details of each step follows.

Step 1. Set up an external pulse input (PI) point in EMCS to accumulate daily consumption for BTU meter.

In I/NET 2000, perform the following steps:

a. Connect sensors that are installed to the controller.
b. Select "Edit", then "Controller", then "Resident I/O Points".
c. Click "Add" and New Resident Point editor will be displayed. Set the following parameters as specified below:

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R,160, 632
Input Type	PI							
Input Address	See Appendix A	280x x is pin # -1 Ex: TB3-1 has the address of 2800 Point: 28 Bit Offset: 00	0000-0007	0000-0007	0000-0007 and 0100-0103	280x x is (pin #-1)/2 Ex: TB5-11 has the address of 2805 Point: 28 Bit Offset: 05	02-04	00-06 except for MR632 00-04
	Click "OK"							
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 BTU							
Scan Interval	1 second							
Point Class	External							
Global Level	Local (for not sharing the point information with other controllers)							
Alarm Priority	None							
Message Priority	None							
Engineering Unit	Select a number that corresponds to the line number of "MMBTU" in Engineering Units Table							
Conversion Coefficient	Select a number that corresponds to the line number of "slope (m) = xxx and offset (b) = 0" in Conversion Coefficients Tables							
Conversion Equation	Linear							
Scan Between Broadcast	60 - (broadcast value of this accumulator every 1 minute)							
Accumulator Type	External 8 bit							
	Click "OK"							

Step 2. Set up an internal pulse input (PI) point to accumulate monthly consumption from the external point created in Step 1.

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Controller”, then “Resident I/O Points”.
b. Click “Add”, and New Resident Point editor will be displayed. Set the following parameters as specified below:

Input Type	PI
Output Address	Choose an unreserved internal address (See Appendix A for the list of hardware point addresses to be avoided)
	Click “OK”
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 Monthly MBtu
Scan Interval	10 seconds
Point Class	Internal
Global Level	Local (for not sharing the point information with other controllers)
Alarm Priority	None
Message Priority	None
Engineering Unit	Select a number that corresponds to the line number of “MBtu”in Engineering Units Table
Conversion Coefficient	Select a number that corresponds to the line number of “slope (m) = 1 and offset (b) = 0” in Conversion Coefficients Tables. If the correct slope and offset are not available, choose an empty pair (m=0, b=0) and enter the correct slope in the conversion coefficient editor (Edit -> Controller -> Station Parameters -> Conversion Coefficients)
Conversion Equation	Linear
Accumulator Type	Reflective
Scans Between Broadcasts	1
	Click “OK”

Step 3. Create a Trend point extension on internal pulse input point in EMCS. This will allow the EMCS to record 15-minute consumption values.

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Controller”, then “Resident I/O Points”.
b. Click the “TR” box at the top of the window.
c. Locate the internal PI point displaying the current consumption (BLDG1 BTU in this example) and click on the point address.
d. Click “Add”, and Trend Extension Editor will be displayed.

Set the following parameters as specified below:

Sample Control Interval	15 minutes
Number of samples	1440 (will keep a fifteen-day rolling history of 15-minute demand readings in controller)
Sample control mode	None
	Leave all other items at their default value and click “OK.”

Application D. Thermal Consumption Monitoring Using an EMCS

Charts D-1 through D-4 will provide the user with steps to set up an EMCS to monitor thermal consumption. By following these steps, the user will enable the EMCS to measure thermal consumption (MMBtu) and store fifteen-minute data. Chart D-1 lists the needed equipment and will help the user determine whether the controller has an available input slot. Chart D-2 aids the user in choosing temperature sensors and a flow meter. The table lists the temperature sensor, flow meter accuracy and output type. Some tips for temperature sensor and flow meter installation are provided as well. Chart D-3 provides an example of a temperature sensor and a flow meter available in the market. Chart D-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to accumulate monthly thermal consumption. The user should then proceed to Application F to set up the data collection and history data storage.

STEP 1. Check the input slot availability on the controller.

Use Chart D-1 to find which slots are needed on the controller. The position of the slot can be found in Chart D-1 under Controller Terminal Connections. For example, the 7740 DCU needs an available slot on Terminal Block TB6 or TB7. If slots are available on either of these, the procedure can be followed. If there are no available slots please contact a TAC-Americas representative to check whether an expansion I/O module can be added to this controller or if an additional controller must be installed.

STEP 2. Choose a Temperature Sensor and Flow Meter.

Chart D-2 lists the temperature sensor and flow meter specifications. For example, an acceptable temperature sensor and flow meter for the 7740 DCU should have analog output (current or voltage output). The end-to-end accuracy of this thermal measurement does not depend only on the meter and sensors but also the characteristics of the system (differential temperature). Chart D-2 and Appendix B provide more information on this. Chart D-3 shows an example of temperature sensors and a flow meter providing a BTU function.

STEP 3. Follow the EMCS programming steps.

Chart D-4 provides the steps to set up the external input point from the temperature sensor and flow meter, and internal points used to store the consumption that the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point and internal points.

STEP 4. Follow the steps in Application F.

Application F lists the steps to set up the data collection and history data storage.

After these steps are complete, the system can collect and store monthly thermal consumption data.

Chart D-1. Thermal Consumption Monitoring Using an EMCS

Verify that in addition to the sensors and transducer, the controller has the available slots as discussed below. In addition, the terminal connections on the controller need to have the resistors connected as specified below.

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
What is measured	• Chilled/Hot water flow • Chilled/Hot water supply and return temperature							
What is stored in EMCS	• Fifteen-minute data of Thermal Consumption in MMBtu unit stored in Trend Data History							
What is needed	1 – Flow meter 2 – Temperature sensors 3 – available slots on Terminal Block (for analog input from flow meter and temperature sensors) 2 – available internal points • 1 – available internal analog output point (to calculate for instantaneous thermal consumption) • 1 – available internal pulse input point (to accumulate month-to-date consumption)							
Terminal Block for Current and Voltage Analog Input	TB1-x or TB2-x For both current and voltage input (0-10 V) Or TB1A-x, TB1B-x TB2A-x, TB2B-x For current input where x can be 1, 4, 7 or 10	TB4–x or TB5-x	TB1 or TB2	TB1 or TB2	TB1, TB2 or TB3	TB6-x or TB7-x	Not Recommended Use PCU 7716 or BTU meter	

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
Resistor in Terminal Block for Current Input	A 249Ω, 1/8W, 0.1% resistor in "A" position	None	A 249Ω, 1/8 W, 0.1% resistor in "A" position			None	Not Recommended Use PCU 7716 or BTU meter	
Resistor in Terminal Block for Voltage Input	A 100KΩ, 1/8 W, 1% resistor in "C" position	None	A 100KΩ, 1/8 W, 1% resistor in "C" position			None	Not Recommended Use PCU 7716 or BTU meter	

Chart D-2. Thermal Consumption Monitoring Using an EMCS

Flow Meter and Temperature Sensor Specifications

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R, 160, 632
Output Type from Flow Meter	Analog, either voltage or current output							
Output Type from Temperature Sensors	Analog, current output							
Maximum Wire Length (ft.)	200 ft. @ 22 AWG (guideline from manufacturer)							
End-to-end Accuracy	End-to-end accuracy depends on the accuracy of temperature sensor, flow meter and how large the temperature difference is. Assuming the difference between chilled water supply and return temperature is 10 °F, the end-to-end accuracy can approach 5%. Assuming the difference between hot water supply and return temperature is 20 °F, the accuracy can approach 7%, without end-to-end calibration. See Appendix B							
Note	Recommended accuracy for temperature sensor: ± 0.2 °F of full scale for chilled water temperature sensors and ± 0.5 °F of full scale for hot water temperature sensor Recommended accuracy for flow meter: ± 1% of full scale Temperature sensors should be matched							

Notes on installation:

- Install the flow meter in either the supply or return pipe.
- Install matched temperature sensors, one on the supply pipe and another on the return pipe.
- For the temperature sensor on the same pipe as the flow meter, install the sensor close to the flow meter.
- Disconnect the flow meter and temperature sensors at the Terminal Blocks. Follow the manufacturer's instructions.

Chart D-3. Thermal Consumption Monitoring Using an EMCS

An Example of Flow Meter and Temperature Sensor Specifications

The following flow meter and temperature sensors have been used successfully.

Temperature Sensor, Minco Products, Inc, RTD with TempTran transmitter		
Input	Temperature Range	30-80 °F (for chilled water system)
Output	Standard Output	Current, 4-20 mA
	Accuracy	± 0.2 % of span

Flow Meter and Transmitter, Rosemount, 8705 with the integral mounted type transmitter model 8732		
Input	Flow Rate	0.04 to 30 ft./sec
	Maximum Pressure	285 psi @ 100°F
	Temperature Condition	Natural Rubber Lining: 0 to 185 °F
	Minimum Liquid Conductivity	5 microsiemens/cm
Output	Standard Output	Current, 4-20 mA
	Accuracy	± 0.5% of rate from 1 to 30 ft/sec and ± 0.005 ft/sec from 0.04 to ft/sec

Chart D-4. Thermal Consumption Monitoring Using an EMCS

EMCS Programming Steps

Summary

1. Set up external analog input points in the EMCS for the flow meter and temperature sensors.
2. Set up internal analog output points in the EMCS for temperature conversion from °F to °C.
3. Create a Trend point extension on the first point set-up in Step 2 to convert the temperature unit from °F to °C.
4. Set up an internal pulse input point in the EMCS for month-to-date thermal consumption.
5. Create a Trend point extension on the second point set-up in Step 4 to calculate the instantaneous thermal consumption.
6. Create a Trend point extension on the internal analog output point in EMC to record 15-minute consumption values.

Details of these steps follow.

Step 1. Set-up external analog input points in the EMCS for the flow meter and temperature sensors

In I/NET 2000, perform the following steps:

a. Connect installed sensors to the controller.

b. Select “Edit”, then “Controller”, then “Resident I/O Points”.

c. Click “Add” and New Resident Point editor will be displayed. Set the following parameters as specified below:

	7756 PCU	7700 DCU	7716 PCU	7718 PCU	7728 I/SITE I/O	7740 DCU	MR 123	MR 88, 88R,160, 632
Input Type	AI							
Input Address	See Appendix A	TB4-x: 0X00 X = x –1 TB5-y: YY00 YY = y + 7 Ex: TB5-1 has the address of 0800 Point: 08 Bit Offset 00	0000-0007	0000-0007	0000-0007 and 0100-0103	TB6-x: 0X00 X = (x –1)/2 TB7-y: YY00 YY = 8 + (y-1)/2 Ex: TB7-1 has the address of 0800 Point: 08 Bit Offset 00	Not Recommended Use PCU 7716	
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 Tchws for Building1 chilled water supply temperature							
Scan Interval	1 second							
Point Class	External							
Global Level	Local (for not sharing the point information with other controllers)							
Alarm Priority	None							
Message Priority	None							
Engineering Unit	Select a number that corresponds to the line number of “°F” for temperature and “GPM” for flow rate in Engineering Units Table							
Conversion Equation	Linear							
A/D Converter	Upper:12 bit Lower:16 bit	12 bit + 1 sign bit	12 bit	12 bit	12 bit	12 bit	Not Recommended Use PCU 7716	

Conversion Coefficient	Use Pop-up Calculator to calculate for slope and offset
Pop-up Calculator	Equipment Count Low: 0 (typical) Equipment Count High: depends on controller A/D converter, 255 for 8-bit, 4,095 for 12-bit and 65,535 for 16-bit Engineering Unit Low: The units being measured for the sensor when the device is at its low count value Engineering Unit High: The units being measured for the sensor when the device is at its high count value
Offset	0 (default) or actual error divide by "slope (m)"to calibrate sensor, compensate for the long wire runs
Low Sensor Limit	The lowest number showing sensor is not in error. This number is the lowest value of this point
High Sensor Limit	The highest number showing sensor is not in error. This number is the highest value of this point
Low Alarm Limit	The lowest number before this point goes into alarm
High Alarm Limit	The highest number before this point goes into alarm, at least equal to High Sensor Limit
Broadcast Change Counts	Round up number of 1% full scale divide by slope (m) For example: highest flow rate is 1000 GPM, Broadcast Change Counts = 0.01*1000/m
Non-linear Lookup Table	0 (no lookup table)

Repeat the above steps to set up analog input points for the flow meter and temperature sensors.

Step 2. Set-up internal analog output points in the EMCS to convert temperature from °F to °C.

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Controller”, then “Resident I/O Points”.

b. Click “Add” and New Resident Point editor will be displayed. Set the following parameters as specified below:

Input Type	AO
Output Address	Choose an un-reserved internal address (See Appendix A for the list of hardware point addresses to be avoided)
	Click “OK”
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 TempC for Building 1 Temperature in °C units
Scan Interval	60 seconds
Point Class	Internal
Global Level	Local (for not sharing the point information with other controllers)
Alarm Priority	None
Message Priority	None
Engineering Unit	Select a number that corresponds to the line number of “C” for temperature in °C in Engineering Units Table
Conversion Coefficient	Select a number that corresponds to the line number of “slope (m) = 0.1 and offset (b) = 0” in Conversion Coefficients Tables. If the correct slope and offset are not available, choose an empty pair (m=0, b=0) and enter the correct slope in the conversion coefficient editor (Edit -> Controller -> Station Parameters -> Conversion Coefficients)
Offset	0
Low Output Limit	0
High Output Limit	100
Broadcast Change Counts	1
	Click “OK”

Step 3. Create a Trend point extension on the first point setup in Step 2 to convert the temperature unit from °F to °C.

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Point Extensions", then "Calculation".
b. Select the point name set-up in Step 2 from the list.
c. Click "Add" and Calculations editor will be displayed. Set the following parameters as specified below.

Equation	(P0-C0)*C1/C2
P0	Select the point of chilled/hot water temperature on the same side with an installed flow meter, analog input point created in Step 1
C0	32
C1	5
C2	9

Step 4. Set up an internal pulse input point in the EMCS for month-to-date thermal consumption.

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Controller”, then “Resident I/O Points”.

b. Click “Add” and New Resident Point editor will be displayed. Set the following parameters as specified below:

Input Type	PI
Input Address	See Appendix A on point address summary. Avoid using those hardware addresses.
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 BTU
Point Class	Internal
Scan Interval	1 second
Global Level	Local (for not sharing the point information with other controllers)
Alarm Priority	None
Message Priority	None
Engineering Unit	Select a number that corresponds to the line number of “MBTU”in Engineering Units Table
Conversion Coefficient	Select a number that corresponds to the line number of “slope (m) = 1 and offset (b) = 0” in Conversion Coefficients Tables
Conversion Equation	Linear
Accumulator Type	Integrating
Scans Between Broadcast	60 (broadcast value of this accumulator every 1 minute)
	Click “OK”

Step 5. Create a Trend point extension on the second point set-up in Step 4 to calculate the instantaneous thermal consumption.

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Controller”, then “Point Extensions”, then “Calculation”.
b. Select the point name set-up in Step 4 from the list.
c. Click “Add”, and Calculations editor will be displayed.

Set the following parameters as specified below:

Equation	C0*P0*(P1-P2)*(C1+C2*P3-(C3*(P3^C4))+(C5*(P3^C6))-(C7*(P3^C8)))
P0	chilled/hot water flow rate point
P1	chilled/hot water return temperature point
P2	chilled/hot water supply temperature point
P3	chilled/hot water temperature on the same side with an installed flow meter (unit in °C), point created in Step 2
C0	8.02486 for chilled water system or 8.01283 for hot water system
C1	999.8395
C2	0.06798
C3	0.00911
C4	2
C5	0.0001
C6	3
C7	1.127e-6
C8	4

Step 6. Create a Trend point extension on internal analog output point in EMCS to record 15-minute consumption values.

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Resident I/O Points".
b. Click the "TR" box at the top of the window.
c. Locate the internal PI point displaying the current consumption (BLDG1 BTU in this example) and click on the point address.
d. Click "Add" and Trend Extension Editor will be displayed

Set the following parameters as specified below:

Sample Control Interval	15 minutes
Number of samples	1440 (will keep a fifteen-day rolling history of 15-minute demand readings in controller)
Sample control mode	None
	Leave all other items at their default value and click "OK."

Application E. Room Temperature Monitoring.

Charts E-1 through E-4 will take the user through steps to set up a temperature sensor to monitor room temperature. Following these steps will enable the EMCS to measure room temperature (°F) and store fifteen-minute data. Chart E-1 lists the needed equipment and helps the user determine whether the controller has an available input slot. Chart E-2 aids the user in choosing a temperature sensor. The chart lists each type of output with sensor accuracy for different controller models. The chart also lists wire and sensor specifications. Chart E-3 provides an example of a temperature sensor available in the market. Chart E-4 provides the EMCS programming steps. By following these steps, the user will enable the EMCS to display current temperature and record 15-minute temperature. The user should then proceed to Application F to set up the data collection and history data storage.

STEP 1. Check the input slot availability on the controller.

Use Chart E-1 to find which slots are needed on the controller. The position of the slot can be found in Chart E-1 under Controller Terminal Connections. There are three types of acceptable temperature sensor inputs for most controllers: current, voltage and thermistor. Any of these inputs are acceptable depending on the application. For example, MR123 needs an available slot on TB3 for a thermistor temperature sensor. If there are no available slots please contact a TAC-Americas representative to check whether an expansion I/O module can be added to this controller or if an additional controller should be installed.

STEP 2. Choose a Temperature Sensor.

Chart E-2 lists the temperature sensor specifications. For example, an acceptable temperature sensor for MR123 should have analog output with ±1°F accuracy or better. The end-to-end accuracy from the temperature sensor to the MR123 controller could be around ±2.5°F. Note that to gain this accuracy the temperature sensor must be placed no further than 200 ft. away with 22 AWG type wire. If this accuracy is not acceptable, a temperature sensor with better accuracy is needed or the controller needs to be replaced. Chart E-3 shows an example of a temperature sensor provided in the market.

STEP 3. Follow the EMCS programming steps.

Chart E-4 provides the steps to set up the external input point from the sensor that the EMCS will need to recognize. Detailed steps provided in this chart must be followed to set-up the external input point.

STEP 4. Follow the steps in Application F.

Application F lists the steps to set up the data collection and history data storage.

After these steps are complete, the system will be able to display the current temperature and record 15-minute temperature data.

Chart E-1. Room Temperature Monitoring

Verify that in addition to the sensors and transducer, the controller has the available slots as discussed below. In addition, the terminal connections on the controller must have the resistors connected as specified below.

	7756 PCU	7700 DCU	7716 PCU 7718 PCU	7251 UC 7270 UC	7728 I/SITE I/O	7740 DCU	MR 55 MR 123	MR 88, 88R,160, 632
What is measured	• Room Temperature							
What is stored in EMCS	• Fifteen-minute data of room temperature in °F units stored in Trend Data History							
Needed	1 – Temperature sensor 1 – Available slot on Terminal Block (depends on output type of each device)							
Terminal Block for Current Analog Input	TB1-x, TB1A-x, TB1B-x, TB2-x, TB2A-x or TB2B-x where x can be 1, 4, 7 or 10	TB4–x or TB5-x	TB1 or TB2	TB1 or TB2 IN1 – IN8 (7251 UC) AI1 – AI8 (7270 UC)	TB1, TB2 or TB3	TB6-x or TB7-x	N/A	TB4
Terminal Block for Voltage Analog Input	0-10 V, upper motherboard TB1-x or TB2-x	TB4–x or TB5-x	TB1 or TB2	TB1 or TB2 IN1 – IN8 (7251 UC) AI1 – AI8 (7270 UC)	TB1, TB2 or TB3	TB6-x or TB7-x	TB4 (MR123)	TB4
Terminal Block for Thermistor Input	N/A	N/A	N/A	TB1 or TB2 IN1 – IN8 (7251 UC) AI1 – AI8 (7270 UC)	TB1, TB2 or TB3	N/A	TB3	TB3 or UI-x

	7756 PCU	7700 DCU	7716 PCU 7718 PCU	7251 UC 7270 UC	7728 I/SITE I/O	7740 DCU	MR 55 MR 123	MR 88, 88R,160, 632
Resistor in Terminal Block for Current Input	A 249Ω, 1/8W, 0.1% resistor in "A" position	None	A 249Ω, 1/8 W, 0.1% resistor in "A" position	With corresponding resistor in "B" position	A 249Ω, 1/8 W, 0.1% resistor in "A" position	None	N/A	A 249Ω, 1/8 W, 0.1% resistor in "A" position
Resistor in Terminal Block for Voltage Input	A 100KΩ, 1/8 W, 1% resistor in "C" position	None	A 100KΩ, 1/8 W, 1% resistor in "C" position		A 100KΩ, 1/8 W, 1% resistor in "C" position	None	None	A 249Ω, 1/8 W, 0.1% resistor in "A" position
Terminal Block for Thermistor Input	N/A	N/A	N/A		A 10KΩ, 1/8W, 1% resistor in "B" position	N/A	None	A 10KΩ, 1/8W, 0.1% resistor in "B" position

Chart E-2. Room Temperature Monitoring

<u>Temperature Sensor Specifications</u>

<table>
<tr><th></th><th>7756 PCU</th><th>7700 DCU</th><th>7716 PCU
7718 PCU</th><th>7251 UC
7270 UC</th><th>7728 I/SITE
I/O</th><th>7740 DCU</th><th>MR 55
MR 123</th><th>MR 88,
88R,160, 632</th></tr>
<tr><td>Output Type from Temperature Sensors</td><td colspan="8">Analog, current, voltage or thermistor output</td></tr>
<tr><td>Accuracy from Temperature sensor</td><td colspan="8">Recommended accuracy for room temperature sensor ± 1.0 °F.
This accuracy can be lower depending on the application used.</td></tr>
<tr><td>End-to-end Accuracy for current output @ 75°F</td><td>Upper MB:
± 1.3 °F
Lower MB:
± 1.09 %</td><td>±1.375 °F</td><td>±1.375 °F</td><td rowspan="3">±TBD °F</td><td>±1.375 °F</td><td>±1.375 °F</td><td>N/A</td><td>±2.5 °F</td></tr>
<tr><td>End-to-end Accuracy for voltage output @ 75°F</td><td>Upper MB:
± 1.075 °F
Lower MB:
± 1.008 %</td><td>±1.075 °F</td><td>±1.075 °F</td><td>±1.075 °F</td><td>±1.075 °F</td><td>±2.5 °F
(MR123)</td><td>±2.5 °F</td></tr>
<tr><td>End-to-end Accuracy for thermistor output @ 75°F</td><td>N/A</td><td>N/A</td><td>N/A</td><td>±2.5 °F</td><td>N/A</td><td>±2.5 °F</td><td>±2.5 °F</td></tr>
<tr><td>Maximum Wire Length (ft.)</td><td colspan="8">200 ft. @ 22 AWG (guideline from manufacturer)</td></tr>
</table>

Chart E-3. Room Temperature Monitoring

Example of Temperature Sensor Specification

Temperature Sensor, Vaisala, HMD 60 Y, Duct Temperature Transmitter		
Input	Temperature Range	-20 to 80 °C
Output	Standard Output	Current, 4-20 mA
	Accuracy	± 0.6 °C over the span
	Linearity	± 0.1 °C or better

Chart E-4. Room Temperature Monitoring

EMCS Programming Steps

Summary

1. Set-up an external analog input point in the EMCS.
2. Create a Trend point extension on an external analog input point in EMCS to record 15-minute temperature values.

Details of these steps follow.

Step 1. Setup an external analog input point in the EMCS.

In I/NET 2000, perform the following steps:

a. Connect the installed sensors to the controller.

b. Select "Edit", then "Controller", then "Resident I/O Points".

c. Click "Add" and New Resident Point editor will be displayed. Set the following parameters as specified below:

	7756 PCU	7700 DCU	7716 PCU 7718 PCU	7251 UC 7270 UC	7728 I/SITE I/O	7740 DCU	MR 55 MR 123	MR 88, 88R,160, 632
Input Type	AI							
Input Address	See Appendix A	TB4-x: 0X00 X = x –1 TB5-y: YY00 YY = y + 7 Ex: TB5-1 has the address of 0800 Point: 08 Bit Offset:00	0000-0007	SSPP00 – SSPP07	0000-0007 and 0100-0103	TB6-x: 0X00 X = (x –1)/2 TB7-y: YY00 YY = 8 + (y-1)/2 Ex: TB7-1 has the address of 0800 Point: 08 Bit Offset:00	00-03 (MR 55) 00,01 or 07 (MR 123)	00-06 except for MR632 00-04
Point Name	Enter a name up to 16 characters in length. For example, BLDG1 Rm1 Temp							
Scan Interval	30 second							
Point Class	External							
Global Level	Local (for not sharing the point information with other controllers)							
Alarm Priority	None							
Message Priority	None							
Engineering Unit	Select a number that corresponds to the line number of "°F" in Engineering Units Table							

	7756 PCU	7700 DCU	7716 PCU 7718 PCU	7251 UC 7270 UC	7728 I/SITE I/O	7740 DCU	MR 55 MR 123	MR 88, 88R,160, 632
Conversion Equation	Linear							
A/D Converter	Upper:12 bit Lower:16 bit	12 bit + 1 sign bit	12 bit	8 bit	12 bit	12 bit	8 bit	8 bit
Conversion Coefficient	Use Pop-up Calculator to calculate for slope and offset							
Pop-up Calculator	• Equipment Count Low: 0 (typical) • Equipment Count High: depend on controller A/D converter, 255 for 8-bit, 4,095 for 12-bit and 65,535 for 16-bit • Engineering Unit Low: The units being measured for the sensor when the device is at its low count value • Engineering Unit High: The units being measured for the sensor when the device is at its high count value							
Offset	0 (default) or actual error divide by "slope (m)"to calibrate sensor, compensate for the long wire runs							
Low Sensor Limit	The lowest number showing sensor is not in error. This number is the lowest temperature.							
High Sensor Limit	The highest number showing sensor is not in error. This number is the highest temperature.							
Low Alarm Limit	The lowest number before this point goes into alarm							
High Alarm Limit	The highest number before this point goes into alarm, at least equal to High Sensor Limit							
Broadcast Change Counts	Round-up number of 5% full scale divide by slope (m) For example: temperature range is 40-100 °F, Broadcast Change Counts = 0.05*60/m							
Non-linear Lookup Table	0 (no lookup table), except for thermistor (consult with TAC-America representative on how to set-up this lookup table							
	Click "OK"							

<u>Step 2</u>. Create a Trend point extension on an external analog input point in EMCS to record 15-minute temperature values.

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Controller”, then “Resident I/O Points”.
b. Click the “TR” box at the top of the window.
c. Locate the internal AI point displaying the room temperature (BLDG1 Rm1 Temp in this example) and click on the point address.
d. Click “Add” and Trend Extension Editor will be displayed.

Set the following parameters as specified below:

Sample Control Interval	15 minutes
Number of samples	1440 (will keep a fifteen-day rolling history of 15-minute demand readings in controller)
Sample control mode	None
	Leave all other items at their default value and click “OK.”

Application F. Data Collection Configuration and Storage In I/NET 2000

Data collection in I/Net is a two-part process. First, the Trend Sampling point extension collects data in the controller memory and directs it to a specific cell on the host workstation. Then, Docutrend Cells provide storage locations on the host computer for data generated by the Trend Sampling point extension. The available space reserved on the host computer's hard drive decreases every time new data is stored in the host workstation. When all the space reserved for a given cell is used, the new incoming data will not be saved. To prevent data loss, Docutrend Cells must be archived periodically. Archived data can still be viewed and exported along with the most current data.

STEP 1. Configuring Host Computer Docutrend Masking.

Follow the step below to configure the host computer to perform Docutrend masking. I/Net utilizes "Message Masking" to manage network traffic. To ensure that the host computer stores Docutrend messages as intended, the Docutrend Masking on the host computer must match the masking on the point generating the data.

In I/NET 2000, perform the following steps:
Select "Edit", then "Host Computer", then "Configuration".
Host Configuration editor will be displayed. Check the appropriate boxes in the "Docutrend Cell" section. The simplest approach in most cases is to check all boxes in all four groups to ensure that the host receives all Docutrend data. Note even in this case, however, the data will be discarded if the Docutrend cell to which it is addressed does not exist.

STEP 2. Defining Docutrend Cell.

Use Chart F-1 to define memory cells in a host workstation. Data collected from a controller will be stored in these locations (cells).

STEP 3. Adding Trend Sampling.

Use Chart F-2 to set the parameters to collect the point data. The Trend Sampling point extension parameters determine how often a sample value is stored, the total number of samples stored in the controller, and the number of samples collected before the data is sent to the Docutrend Cell in the host computer. Data is stored in the host computer at a specified cell, a block of hard disk drive storage space reserved for I/Net data storage.

STEP 4. Archiving Docutrend Data.

Follow the steps below to save on-line Docutrend data to an archive file preventing data loss resulting when the RWONLN file size reaches its maximum capacity.

a. Select “Edit”, then “Host Computer”, then “Docutrend Cell Inquiry/Edit”, then “Archive Data”.
b. Highlight a cell in the cell list.
c. Set the latest date and latest time as desired.
d. Choose “New Archive”.
e. Select “Archive All”.
f. Insert the disk and select “OK”.

It is recommended to archive the data at least once a month.

Chart F-1. Data Collection Configuration and Storage In I/NET 2000

Defining Docutrend Cell

In I/NET 2000, perform the following steps:

a. Select “Edit”, then “Host Computer”, then “Docutrend Cell Inquiry/Edit”, then “Cell Directory”.

b. Click “Add”, then enter a new cell number in Directory window.

c. Click “OK” and Cell Details Editor will be displayed. Set the following parameters as specified below.

Cell Name	Enter a name up to 16 characters in length
Cell Type	Analog (except the daily consumption and peak demand values generated by the Demand Control point extension. These values require a “Demand” cell type)
Transient duration (days)	45
	Click “OK”

Chart F-2. Data Collection Configuration and Storage In I/NET 2000

Adding Trend Sampling

In I/NET 2000, perform the following steps:

a. Select "Edit", then "Controller", then "Point Extensions", then "Trend Sampling".

b. Locate the point to be trended and click on the point address.

c. Click "Add" and Trend Extension Editor will be displayed, Set the following parameters as specified below.

Distribution Group	Select one of the four numbers which corresponds to the distribution group defined in the host workstation where this data will be stored
Distribution Mask	Check masking box(es) to match those on the desired host computer workstation. If all boxes are checked in all groups on the Host computer, then checking any box in any group will log the data on that host.
Priority	Routine
Cell Number	Enter the corresponding number of cells as defined above
Cell Sample Count	4
Base Time	00:00
Interval (minutes)	15
Number of samples	200
Sample control mode	None
	Click "OK."

APPENDICES

Appendix A: Reserved Point Addresses

Appendix B: Thermal Consumption Accuracy

Appendix A: Reserved Point Addresses

Table A.1 gives point address information for the various TAC-Americas controllers. Each point is assigned a ten-character point address composed of link, station, point, bit-offset numbers, and the two-letter point type. The point address is in the form LLSSPPBB PT, where LL designates the link, SS designates the station, PP designates the point, BB designates the bit offset, and PT designates the point type. The link and station numbers were assigned at the time of installation. Table A.1 lists the hardware point addresses for each point type. For example, the sensor installed in 7700 DCU, PI base unit slot 1, will be recognized as the hardware point 2800 PI. This table also reminds the user to avoid using these hardware points as a software or internal address points.

Table A.1 Controller Point Addresses

Controller	Hardware Point Addresses	
	Point or Board Type	Range (PPBB)
7700 DCU	DI / PI base unit	2800 –2807
	DI / PI expansion slot 3	2900 – 2907
	DI / PI expansion slot 2	3000 – 3007
	DI / PI expansion slot 1	3100 – 3107
	DO / PWM base unit	0000 – 1500
	DO / PWM expansion slot 1	1600 – 2300
	AI base unit	0000 – 1500
	AI expansion slot 4	1600 – 2700
	AO expansion slot 2	2400 –2700
	AO expansion slot 3	2800 – 3100
7716 PCU	Universal Input (UI) base unit	0000 – 0007
	DO base unit	0000 – 0007
	UI / DO expansion board: Inputs	0100 – 0107
	Outputs	0100 – 0107
	UI / AO expansion board: Inputs	0100 – 0107
	Outputs	3100 – 3103
	RTD expansion board	0100 – 0107
	AO expansion board	3100 – 3103
	Base HOA switch feedback	BB 08 & 09 on points 00-07
	Expansion HOA switch feedback	BB 08 & 09 on points 08-15
7718 PCU	Universal base unit	0000 – 0007
	DO / PWM base unit	0000 – 0007
	DO / PWM expansion board	0100 – 0107
	AI / DI / PI expansion board	0100 – 0107, 0200 – 0207
	AO base unit	3100 – 3107
	Base HOA switch feedback	BB 08 & 09 on points 00-07
	Expansion HOA switch feedback	BB 08 & 09 on points 08-15

Table A.1 (continued) Controller Point Addresses (continued)

Controller	Hardware Point Addresses	
	Point or Board Type	Range (PPBB)
7728 I/SITE	Universal Inputs	0000 – 0007, 0100 – 0103
	I/STAT	0104 – 0105
	Analog outputs	3100 – 3103
	Triac outputs	0000 – 0007, 0100 – 0101
	Auxiliary outputs	0102 – 0103
7740 DCU	DO / PWM base unit	0000 – 1500
	AI base unit	2800 – 2807
	DI / PI base unit	0000 - 0707
7756 PCU	DI / AI / PI upper motherboard	0000 – 0007
	DI / AI / PI lower I/O board	0100 – 0107, 0200 – 0207
		0300 – 0307
	DO / PWM upper motherboard	0000 – 0007
	DO / PWM lower I/O board	0100 – 0107
	AO lower I/O board	3100 – 3107
	HOA switch feedback upper motherboard	BB 08 & 09 on points 00-07
	HOA switch feedback lower I/O board	BB 08 & 09 on points 08-15
MR 55	DO / PWM	00 – 04
	DI / Thermistor	00 – 03
	CFM / LPS Transducer (MR55X only)	04
	I/STAT or Thermistor	07
MR88	Universal inputs	00 – 06
	DO (low voltage triac)	00 – 07
	I/STAT	07
MR88R	Universal inputs	00 – 06
	Form-C relay outputs	00 – 07
	I/STAT	07

Table A.1 (continued) Controller Point Addresses (continued)

Controller	Hardware Point Addresses	
	Point or Board Type	Range (PPBB)
MR123-032MB	AI DO (high voltage triac) DI AO I/STAT	00 – 01 00 – 02 02 – 04 03 – 04 07
MR123-210MB	AI DO (high voltage triac) DI DO (low voltage triac) I/STAT	00 – 01 00 02 – 04 03 – 04 07
MR123-210MB	AI DI DO (low voltage triac) I/STAT	00 – 01 02 – 04 03 – 06 07
MR123-430MB	AI DO (high voltage triac) DI DO (low voltage triac) I/STAT	00 – 01 00 – 02 02 – 04 03 – 06 07
MR160	Universal Inputs I/STAT	0000 – 0007, 0100 – 0106 0107
MR632	DO (low voltage triac) Universal Inputs AO I/STAT	00 – 02 00 – 04 03 – 04 07
7251 UC and 7270 UC	Universal Inputs Discrete outputs	00 – 07 00 – 07

Appendix B: Thermal Consumption Accuracy

The accuracy of thermal consumption depends on temperature sensor accuracy, flow meter accuracy, and the temperature difference as shown in the following tables. Each table represents the thermal consumption calculation accuracy based on a specific temperature difference, combinations of temperature sensor accuracy, and flow meter accuracy. For example, if a chilled water system has a temperature difference between the supply and return at 8 °F and we would prefer controlling the thermal consumption accuracy to be below 10%, we can select several combinations of temperature sensors and flow meter from the accuracy shown in Table B.2. We can choose a temperature sensor at 0.2 or 0.5°F accuracy with a flow meter of 0.5, 1 or 2% accuracy. For instance, 0.5°F accuracy temperature sensors and a 2% accuracy flow meter with an 8°F temperature difference yield 8.38% thermal consumption calculation accuracy. A better accuracy can be gained with a more accurate temperature sensor, a more accurate flow meter, or a higher difference in temperature. With the above example, the thermal consumption accuracy can be improved from 8.38% to 4.55% with 0.2°F temperature sensor replacement. Note that the above accuracy does not include the accuracy from the controller reading, signal loss along the wire, etc. That accuracy only takes the temperature sensor and flow meter into account.

Table B.1 Thermal accuracy calculation based on a 5 °F Temperature difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	4.52 %	10.55 %	20.60 %	40.70 %
1	5.04 %	11.10 %	21.20 %	41.40 %
2	6.08 %	12.20 %	22.40 %	42.80 %

Table B.2 Thermal accuracy calculation based on a 8 °F Temperature difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	3.01 %	6.78 %	13.06 %	25.63 %
1	3.53 %	7.31 %	13.63 %	26.25 %
2	4.55 %	8.38 %	14.75 %	27.5 %

Table B.3 Thermal accuracy calculation based on a 10 °F Temperature difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	2.51 %	5.53 %	10.55 %	20.60 %
1	3.02 %	6.05 %	11.10 %	21.20 %
2	4.04 %	7.10 %	12.20 %	22.40 %

Table B.4 Thermal accuracy calculation based on a 12 °F Temperature difference

Flow meter accuracy (%)	Temperature sensor accuracy (°F)			
	0.2	0.5	1.0	2.0
0.5	2.18 %	4.69 %	8.88 %	17.25 %
1	2.68 %	5.21 %	9.42 %	17.83 %
2	3.70 %	6.25 %	10.50 %	19.00 %